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Telephone: 6611 Gerrard (2 lines).
Telegrams: Zacatecas, Westrand, London.

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Forthcoming Events.

APRIL 2.

North-East Coast Institution of Engineers and Shipbuilders (Graduate Section):—Ordinary meeting at Middlesbrough. "Boilers," Paper by L. Close.

West of Scotland Iron and Steel Institute:—Annual general meeting at Glasgow.

APRIL 3.

Institute of British Foundrymen (Lancashire Branch):—Annual general meeting at Manchester. "Pattern-making and its Relation to Design and Foundry Practice," Paper by R. Kemlo.

APRIL 9.

Society of Chemical Industry (Manchester Section):—of Coal." Paper by R. V. Wheeler.
Ordinary meeting at Manchester. "The Constitution

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

Institute of British Foundrymen.

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Secretary: K. S. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.

The London Congress.

It would be idle to suggest that London is the centre of the foundry industry, but we certainly believe that no other district can show a wider range of cast products. It has been the intention of the London Convention Committee so to arrange the works visits for the forthcoming Conference in June that every branch of the industry should be represented, and so excellently have the district employers responded that facilities have been given for the inspection of grey iron, steel, malleable iron and non-ferrous foundries. Not only has this general classification been satisfied, but in grey iron, marine, light, electrical and general, and in malleable both Reaumur and Blackheart are included in the list; whilst a fair range is available from the non-ferrous trades. The London Conference is to have associated with it the undoubted advantage of a foundry equipment exhibition, to be held concurrently at the Agricultural Hall. The response from foreign buyers has been much greater than ever previously, and a very large number have accepted invitations to visit the Exhibition, whilst about 1,000 have asked for a copy of the Exhibition catalogue to be sent to them. In recent years there has been a marked improvement in the quality of machinery and supplies for foundry use. Coal dust looks very much as it always did, to take a simple illustration, but nowadays there is a guarantee as to ash content. With refractory materials, too, figures are available for their melting points, both normal and under pressure, their heat conductivity, reactivity to slags, and quantity of other data. Output from machinery, upkeep costs in its relationship with transport facilities have similarly been studied. These are factors which are appreciated in all countries, and the guarantee of such marked interest by foreign buyers makes it essential that British foundry owners should make a special effort not only to be present in person, but also to grant facilities to as many members of their staff as business conditions will allow. For the members of the Institute many social functions have been organised. The annual banquet is to be at the Hotel Cecil, and for this function many eminent people have already accepted invitations. The Right Hon. Arthur Henderson, P.C., M.P., has promised to open the Conference. On Tuesday evening, June 15, a reception is being held at the Old County Hall, where provision has been made for 400 guests. Granted no trade upheaval, it is felt that this number can be confidently counted upon to participate.

There are eight Papers to be submitted to the Conference. The American Exchange Paper is to be submitted by Mr. Arnold Lenz, of the Saginaw Products Company, Saginaw, Michigan. Mr. Lenz is one of the foremost foundrymen in America on the production of motor castings, as he has charge of the development of methods for casting productions for his firm, which produces most of the castings for the General Motors Company. The French Exchange Paper is in the capable hands of M. Lemoine, who will deal with moulding sands. The Belgian Association have asked M. Piedboeuf to present a memoir on High Tensile Cast Iron. From Great Britain there are to be Papers from Professor Thompson, of Manchester University; Mr. J. G. S. Primrose, Mr. Gerald Bagshawe, Mr. Partridge, and Mr. Yates.

An interesting programme has also been arranged for ladies.

B.C.I.R.A. Falkirk Meeting.

Scottish Committee Appointed.

As was announced in these columns some time ago, an amalgamation was effected last year between the Foundry Technical Institute, Falkirk, and the British Cast Iron Research Association. Both the Association and the Institute had a number of members in Scotland, and it was felt that a proper working arrangement would lead to greater economy and efficiency of working.

On Wednesday, March 24, the first formal meeting of the united bodies was held, comprising both existing members of the Association and supporters of the Falkirk Foundry Technical Institute. The meeting was held in Falkirk for the purpose of electing a Scottish Committee and inspecting the Institute.

A civic reception was accorded the visitors at the Borough Chambers, Falkirk. Provost Gilchrist, who was supported by a number of magistrates and councillors, opened the proceedings and extended a very cordial welcome to all present. He referred to the deep interest that the Town Council had always taken with regard to the ironfounding industry in the Falkirk area and on which Falkirk was completely dependent. Referring to the excellent work of the Foundry Technical Institute which had been very well done in the past, he said that under a national body like the B.C.I.R.A. a greater success would attend the work of the Institute, and it was only appropriate that a centre of the Association should have been set up in Falkirk, the centre of the light castings industry. They welcomed any change tending towards the improvement of the industry.

The Chairman (Mr. A. W. Steven), on behalf of the meeting, thanked the Provost for expressing his welcome on behalf of Falkirk, to which the Provost suitably replied.

There were forty to fifty people present at the meeting, including Mr. J. Cameron (President I.B.F.), Prof. J. H. Andrew (Professor of Metallurgy, Royal Technical College, Glasgow), Capt. H. J. Kennard, R.N. (Falkirk Iron Company, Limited), Mr. Geo. A. Ure (Smith & Wellstood, Limited), Mr. J. G. Pearce (Director and Secretary B.C.I.R.A.), Mr. H. Cowan (Superintendent, Foundry Technical Institute), Mr. J. Allan (Secretary, Foundry Technical Institute), and all the borough officials.

The Chairman announced apologies for absence from the Rt. Hon. Lord Weir (Past-President, B.C.I.R.A.), who was detained in Glasgow on urgent business, Sir Wm. Ellis (Vice-President, B.C.I.R.A.), Mr. H. B. Weeks (Chairman of Council, B.C.I.R.A.), Prof. A. Mellanby (Professor of Mechanical Engineering, Royal Technical College, Glasgow), Mr. V. C. Faulkner (Vice-President, I.B.F.), and others.

The Chairman pointed out that the Foundry Technical Institute had, since its inception in 1917, enjoyed the devoted services of Mr. J. C. Jeffrey Smith (Camelon Iron Company, Limited) as chairman. Mr. Jeffrey Smith was quite sympathetic towards the amalgamation, and had done his utmost to bring it about when negotiations were opened early in 1925. It was unfortunate that ill-health had prevented him taking the chair at this meeting, but he had written from Italy expressing his good wishes for the future. Mr. Jeffrey Smith's retirement from active business would prevent him taking further active part in the work of the Institute. On the motion of the Chairman, it was unanimously agreed to send Mr. Jeffrey Smith a cordial letter of appreciation for his devoted service, and to express the meeting's best wishes for his complete restoration to health.

The Chairman, in the course of his opening remarks, outlined the circumstances which led to the formation of the Institute in 1917, some years prior to the establishment of the B.C.I.R.A. He emphasised the fact that the ironfounding industry was capable of improvement in many ways. He believed they were only in the early stages of ironfounding, which had not made much progress as compared with the steel and allied industries. A change was coming, however, particularly in the advancement of technical efficiency and in a higher quality of the goods they produced. The Falkirk Foundry Technical Institute was the first in the field to attempt to improve matters, for the need for improvement was first felt to be greater in Falkirk than elsewhere. This was the first meeting of the two bodies since the amalgamation, and although the Foundry Technical Institute had done splendid work in the past for the scientific side of the ironfounding industry, it was capable of doing much more in the future. The B.C.I.R.A. had an excellent record, which reflected great credit on this who controlled it. The amalgamation would still further help them, both in the quality of their products and in the direction of economy in production. He then called upon Mr. J. G. Pearce, Director and Secretary of the B.C.I.R.A. Mr. Pearce briefly outlined the history of the Association, and stated that the amalgamation had been considered desirable solely to unify efforts to improve cast iron and to provide the ever increasing Scottish members with a local centre. For these purposes no better location than Falkirk could be found. Members of the Institute would in future have the advantages of membership with the Association, which this year was spending £9,000 on its work, and Association members would have the advantages of a local Institute and a Scottish Committee to serve their interests and arrange the programme of work to be done. They would continue to have the services of Mr. Cowan as Superintendent of the Institute and Mr. Allan as Secretary. Mr. Pearce reviewed the work in hand and emphasised that the Association welcomed enquiries from and personal contact with members and were anxious to make membership a business proposition. They wanted comment and suggestions from members regarding work in hand and projected, so as to make the Association a truly co-operative body. They desired to enrol as members all engineering works, foundries and blast-furnace plants in what was a national effort to meet competitive developments abroad.

The Chairman then put before the meeting a series of recommendations of the retiring committee, with regard to the formation of the new Scottish Committee and the following were unanimously elected:—Capt. H. J. Kennard, R.N. (Falkirk Iron Company, Limited), Mr. G. A. Ure (Smith and Wellstood, Limited), Mr. John Walker (Walker, Hunter and Company, Limited), Mr. T. Downie (Grahamston Iron Company, Limited), Mr. A. W. Steven (McDowell, Steven and Company, Limited), Mr. J. B. McTurk (Dorrator Iron Company, Limited), and Mr. G. L. Anderson (Camelon Iron Company, Limited), representing the retiring Committee, Mr. Geo. Pate, O.B.E., J.P. (Carron Company), Mr. H. B. Weeks (Vickers, Limited), Mr. J. G. Pearce (Director, B.C.I.R.A.), and Mr. J. E. Fletcher (Consultant, B.C.I.R.A.), representing the B.C.I.R.A. ex-officio, Mr. J. Arnott (G. and J. Weir, Limited), Mr. John Cameron, J.P. (Cameron, Roberton, Limited), and Mr. J. M. Primrose (Grangemouth Iron Company, Limited). It was agreed that four other gentlemen should be approached with a view to joining the committee, and that the Chairman should be elected by the Committee and be appointed a Member of Council of the Association.

The Chairman then called upon Mr. John Cameron, President of the I.B.F., who testified to the excellent work done both by the Foundry Technical Institute and the Association, and expressed his gratification at the amalgamation in which he was proud to have had some share. Mr. Geo. A. Ure proposed a vote of thanks to the Chairman, which was carried with acclamation.

The assembly then adjourned to the Foundry Technical Institute and inspected the Institute, including the chemical, mechanical testing and experimental laboratories, further illustrated details of which we propose to publish at a later date.

Particular interest was shown in the mechanical testing department, especially the 50-ton electrically driven tensile testing machine. The work of the Institute was explained by the Superintendent, Mr. H. Cowan, and the visitors were impressed with the nature of the work carried out. Members and visitors were entertained to tea after the inspection.

Lifting and Shifting Appliances in Foundries.*

By H. H. Moore.

The wise man, long ago, said, "*Where there is no vision the people perish*," and this wisdom applies to the foundry industry as well as to more general forms of activity, so, in planning new foundries, or making changes in old ones, let us look ahead, and see where economies can be effected and production increased. Of course, the old plant in some of our foundries works, but it is slow and inefficient; it eats up the cost of itself year after year, because somebody will not see the losses or will not have the courage to consign it to the scrap heap.

It has been stated in recently published reports by prominent foundry engineers in the United States of America that in one automobile foundry some 69 tons of material are moved once for each ton of castings produced. In another automobile foundry 55 tons of material and equipment are moved to each ton of finished castings—and that in a bath-tub foundry 137 tons of material are handled for each ton of castings produced. A large jobbing foundry in the U.S.A., it is stated, handles 200 tons of material for each ton of castings that get to the despatch department.

The Foundry Trade Journal of January 22, 1925, in a leader on the same subject, entitled "Where Can the Maximum Economy in Foundry Practice be Effected?" mentions "that the manufacture of one ton of grey iron castings involves handling 168 tons of material, and that probably in a malleable ironfoundry this figure would reach well over 200 tons," and it is rightly suggested that "the efficient and economical handling of these materials offers a very profitable field of investigation for every foundryman."

A very interesting analysis covering the handling of castings in a brass foundry, given in the form of a Paper presented to the American Foundrymen's Association by Mr. T. C. Flinn, was published in The Foundry Trade Journal of October 27, 1925, and is well worth careful perusal, as it shows that in a brass foundry having a total output of some 2,500 lbs. of castings per day, 152 tons of material are handled to produce 1 ton of castings.

There appears to be a considerable discrepancy in the figures mentioned, but, again, Mr. J. M. Primrose, of Falkirk, a valued member of the Institute, reading a Paper† some time last year on "The Conveyance of Material in the Foundry" (with special reference to the production of light castings), stated that in a light castings foundry melting 30 tons per day the material handled is, in round figures, 255 tons, made up of:—5 tons coke; 30 tons pig and scrap; 10 tons new milled facing sand; 30 tons of molten metal; about 10 tons gates and runners, and 20 tons of castings.

And allowing 1 ton of sand per moulder (which he says is understated), say some 70 tons of sand, handled twice, the total stated is reached. Mr. Primrose says "eliminate some of the time in handling parts of this bulk, and a rise in the output of castings should soon be observed; the work done by the unskilled man in this foundry (if there is such a person) means 105 tons, comprising coke, pig-iron and scrap, milled sand, molten metal, gates and castings, and it should not be difficult to invent some system which will at least materially reduce the non-productive labour."

The whole subject warrants careful attention and serious consideration, for while some foundries in this country are well equipped for the handling of materials, yet the majority have yet much to do in the way of necessary labour saving, speeding up, and cost cutting appliances.

For any operation in handling of materials several methods of performance are sure to be found, and one will be found better than another for certain reasons, and less desirable for certain other reasons. At this point then the mind must consider other things than the operation itself, such as its relation to previous and subsequent operations, and its suitability for the particular requirements of the work, its period of usefulness, and so on, and, what is very important, the financial return on the investment.

The tendency of the age is towards the conservation of the natural resources of the world, and in handling of materials to the conservation of labour effort.

When labour is high priced the necessity for apparatus is increased, and decides that machinery is necessary, where, if suitable labour can be secured, the operation would be performed by hand more cheaply than by plant adopted.

Frequently it will be found in the handling of material that the advantage of reducing the physical effort is not only an economic advantage in that it directly reduces costs, but also that it reduces the number of men needed, and brings their work within the physical power for human effort. A man may lift 100 lbs., but he cannot do it all day long.

Work must be really interesting before men will continue to do it well, so in securing handling economies the wise will avoid the necessity of handling operations wherever possible, and solve the individual cases thus reduced in number by the means that will keep down the labour effort and save the money in operating costs.

The way to handle material cheaply is to avoid handling it at all, if such a state of things were possible.

Whatever device is used in the foundry for lifting and shifting, the following two elementary principles should be borne in mind:—(1) In handling material carry out only the operations that are absolutely necessary; and (2) perform these operations in the way that secures the lowest cost.

A large dredging contract in a harbour in China, let us say Hongkong, was to be let some years ago. As hydraulic dredges are most economical, and usually do such work for the lowest cost, a representative of a large dredging company, realising there were very few, if any, large dredgers in China, thought that he could underbid, and secure a valuable contract. On arrival at Hongkong, however, he found that he was right, for there were no hydraulic dredges to bid against him. He had a fine one available, but he found also, to his chagrin, that coolie labour was so cheap that a coolie could carry the earth out of the excavation in baskets on his head at so low a cost per yard that it was more economical to drive piles around the earth, pump out the water, and carry the mud by coolie labour.

It is needless to say that the work was done by coolie labour, and that was the most economical method under the existing conditions, but such a state of things hardly exists to-day; this illustration will force on one's mind the fact that the device that is most economical in handling material at one place, and under one sort of condition of labour and environment, may not be the most economical in another place. This fact should always be borne in mind, for it is of vital importance.

But under any set of circumstances there is a rule that applies to all handling problems, and one that can be depended on to aid the mind in selecting a good workable plan. It is in general terms nevertheless of great value, as all plans can be tested by applying its principles. This rule can be stated as follows:—The material under operation should follow a direct route, from receipt or start on to final shipment or despatch, with as few retrograde movements as possible, and the articles being made or manufactured should go directly from operation to operation, or stage to stage, without rehandling.

Commencing with the cupola, pig-iron and coke are mainly man-handled, first from the truck, finally on to the charging platform, and thence to the cupola. There are many methods of charging

D

* A Paper read before the East Midlands and Sheffield Branches of the Institute of British Foundrymen, Mr. Stevenson presiding. The author is Managing Director of Herbert Morris, Limited, Loughborough.

† "F.T.J." February 26, 1925, page 188.

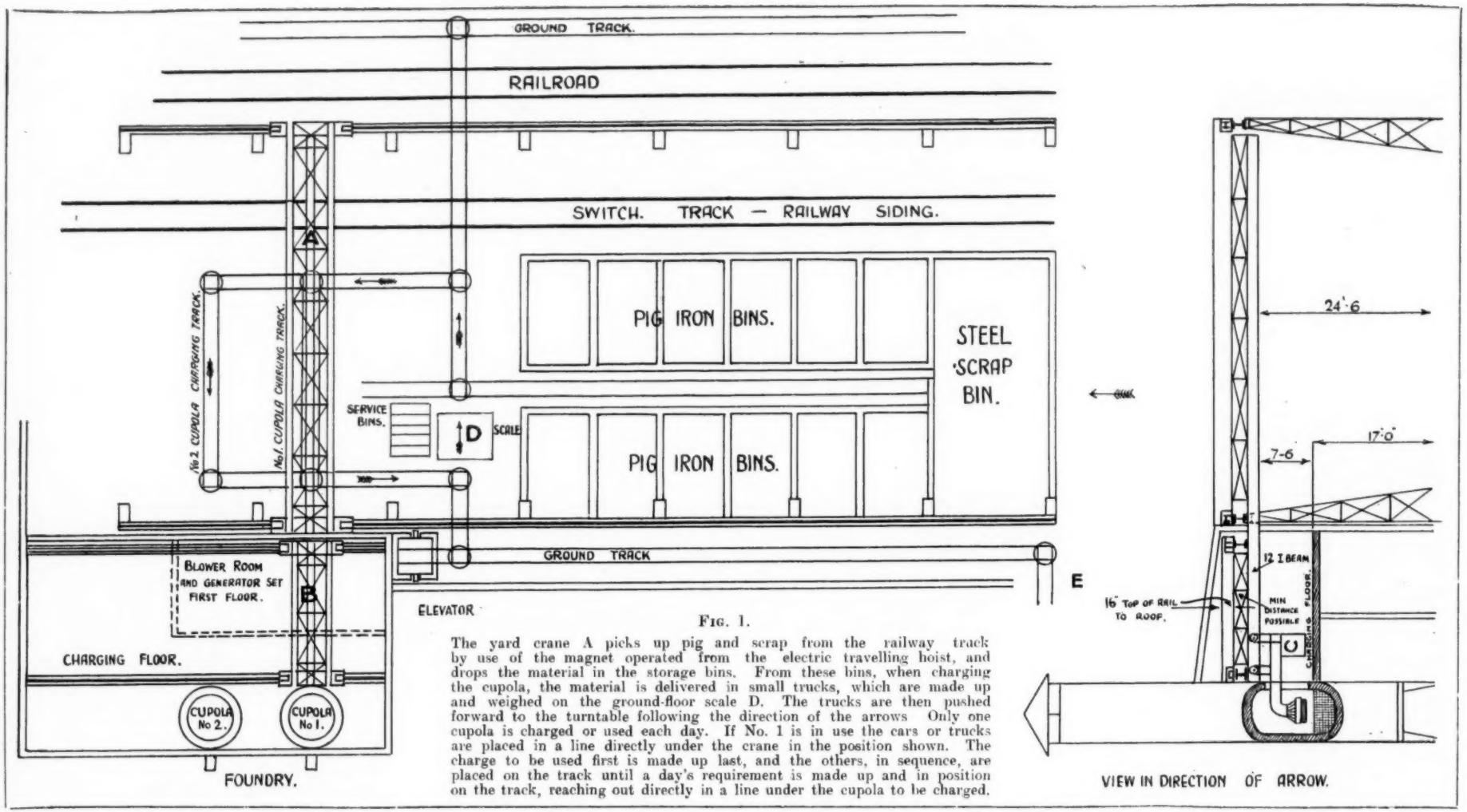


FIG. 1.

The yard crane A picks up pig and scrap from the railway track by use of the magnet operated from the electric travelling hoist, and drops the material in the storage bins. From these bins, when charging the cupola, the material is delivered in small trucks, which are made up and weighed on the ground-floor scale D. The trucks are then pushed forward to the turntable following the direction of the arrows Only one cupola is charged or used each day. If No. 1 is in use the cars or trucks are placed in a line directly under the crane in the position shown. The charge to be used first is made up last, and the others, in sequence, are placed on the track until a day's requirement is made up and in position on the track, reaching out directly in a line under the cupola to be charged.

in use, but worthy of note is a method originated in the U.S.A. in which the stockyard overhead travelling crane links up with an inside overhead traveller running over the charging platform, the yard crane and the charging platform crane, both travelling for their respective work on their respective gantries, but both being of the transporter type, namely, each carrying a single joist, so that by means of a system of automatic stops the cranes can lock up in one line, and an electric travelling hoist running on the bottom flange of the joists can be used right across the two, or separately on either crane, for the efficient handling of materials from the railway truck to the yard, and from the yard into the cupola.

The outside crane in Fig. 1 is used to unload all raw materials, either with a magnet or grab bucket. It serves also to make up the charges on suitable trucks on the ground track, and is used in conjunction with the inside crane to deliver the material directly from the ground track trucks to the inside of the cupola.

When the ground-track trucks are filled, and arranged as shown in Fig. 1, the cycle of charging operations is started by running the electric hoist or charger out along the outside crane, the magnet or bucket is dropped down, and the material, either coke or iron, is lifted up to its full height, so that the suspending rope and cable is sheathed well within the frame of the hoist. The hook on the magnet is sheathed within the cantilever arm, so that swinging or damage to the hoist rope whilst the arm is in the cupola is avoided. The E.T. hoist is then run forward off the yard crane to the inside charging crane, and along until the coke bucket, or the iron on the magnet, as the case may be, is inside the cupola. The charge is then dropped, and the charging hoist returns to complete the cycle of operations. It is stated that by this method some 15 tons of iron, etc., per hour is easily handled from the ground to the inside of the furnace.

The labour-saving feature of this arrangement is shown by a comparison with the old hand practice, formerly 24 men were required to handle the material for an output of 80 tons of iron per day from one cupola, this number of course, covering all the yard and charging floor labour necessary to handle all material from the railway truck to the storage piles, from the piles, or storage, to the ground track trucks, and from these trucks to the cupola (not merely cupola charging) making three separate lifts of the same material, or 240 tons in all. At present six men can make up and charge the required material to obtain the production of 80 tons per day of metal at the spout.

Coke is handled from the charging floor, or from the ground, as may be desired; a novel bucket, with a holding capacity of 400 to 600 pounds of coke, is set down by the coke storage, and filled by forking the coke into it. This coke bucket is transferred to the cupola by use of the magnet which is dropped over the bucket, and depresses the hinged lid, this throws the hooks forward, which engage the top of the magnet, and the bucket can be lifted without fear of its being disengaged until the hoist runs it into the cupola, when a pull of a hook disengages a latch, which allows the bottom of the bucket to drop ten inches on a central rod, and distribute the coke evenly: the bucket is then run out and put to work again, the action of the bottom touching the floor or ground being sufficient to close it up again. Now this system may seem only suitable for large outputs, but it certainly opens one's eyes to what might be done on a smaller scale for even medium size foundries, with very economical results.

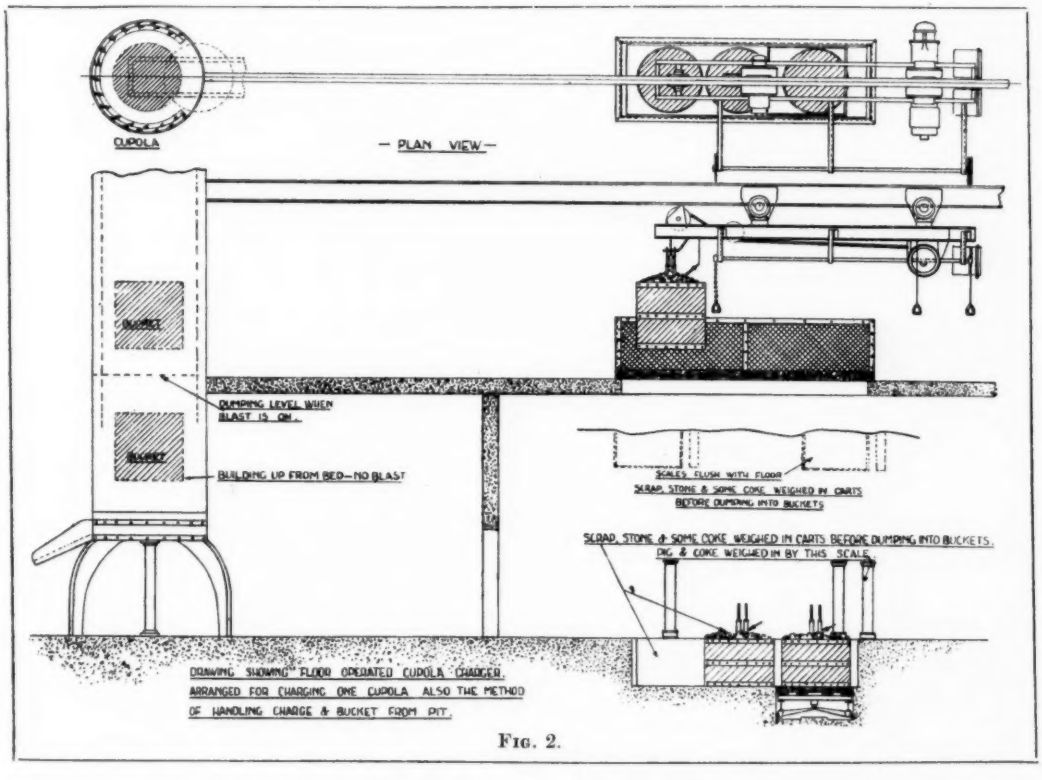

CUPOLA
— PLAN VIEW —
DUMPING LEVEL WHEN BLAST IS ON.
BUILDING UP FROM BED—NO BLAST
SCALES FLUSH WITH FLOOR
SCRAP, STONE & SOME COKE WEIGHED IN CARTS BEFORE DUMPING INTO BUCKETS
SCRAP, STONE & SOME COKE WEIGHED IN CARTS BEFORE DUMPING INTO BUCKETS.
PIG & COKE WEIGHED IN BY THIS SCALE
DRAWING SHOWING FLOOD OPERATED CUPOLA CHARGER ARRANGED FOR CHARGING ONE CUPOLA ALSO THE METHOD OF HANDLING CHARGE & BUCKET FROM PIT.

FIG. 2.

Another system, somewhat similar to the one just mentioned, and shown on Figs. 2 and 3, which describe even simpler schemes than the one outlined in Fig. 1. Of course the electric hoist can in either case be used also with the skull-cracker for breaking up scrap.

Self-acting chargers, operating from the ground floor are now more in evidence, and take the filled trucks, carry them up an inclined conveyor, and deliver the charges directly into the cupola, and they seem to have much greater possibilities for the smaller foundry.

The fourth scheme, Fig. 4, is one used to advantage in this country, and is, in the author's opinion, a very good one where melting is going on practically continuously, and overcomes the rehandling to a good extent. It uses two overhead runways, the lower one being operated either by hand, or an electric hoist, and the upper one being preferably of the electric type, but in this scheme, charges can be pre-arranged on the ground, or on the charging platform, as best suits the conditions obtaining; in either case tipping skips are used, charges made up on the ground, or ground floor, weighed in the skip, and transferred by the elec-

tric hoist from the lower runway to the upper runway, where the charging can be done direct into the cupola in a very simple manner.

(Here some 40 views were shown of cranes and lifting gear of interest to the foundry trade.)

Electric Cranes.

Electric cranes are so well known that little need be said, but a Paper* recently read by Mr. Daniel Adamson is well worth perusal. Electric cranes are indispensable, and a foundry not properly equipped with its full quota cannot be efficient. Foundrymen buying cranes should be most careful to get "foundry cranes" with proper creeping control, or otherwise they will lose a great advantage.

With regard to the type of hand-pulley blocks, and ruling out the type of block coming under the heading of differential in its varieties, it can be said that the geared self-sustaining hoist, or pulley block, operated by hand, still holds the field as the most economical device up to about 50 ft. of lifting and lowering per hour, above this amount an electric or other power-driven hoist is the more economical.

* Manchester Association of Engineers.

Fig. 5 shows the total operating cost of various types of lifting machinery, in pence, per hour, for a given number of feet of lifting and lowering per hour accomplished. The example is taken for 1-ton loads, and includes interest and depreciation. This diagram has been plotted for a hoisting mechanism pure and simple.

In the case of cranes where the proportional costs of hand and power cranes is less, the power crane becomes economical much sooner, and it may be taken as a rough and ready rule that where the amount of lifting and lowering per hour exceeds 10 to 15 ft., it is wise to compare total operating costs with a view to deciding the most economical type to be employed. The greater the tonnage to be lifted, the sooner does a power crane become the best investment.

Fig. 6 illustrates the range of economy of various types of lifting mechanism under various conditions. In general, while a plant is being served by a lifting gear, the plant is at rest or partially so. Consequently, standing charges of many kinds are proceeding without useful work being done to pay these charges. The spaces between the curves show the range of economy of the several types

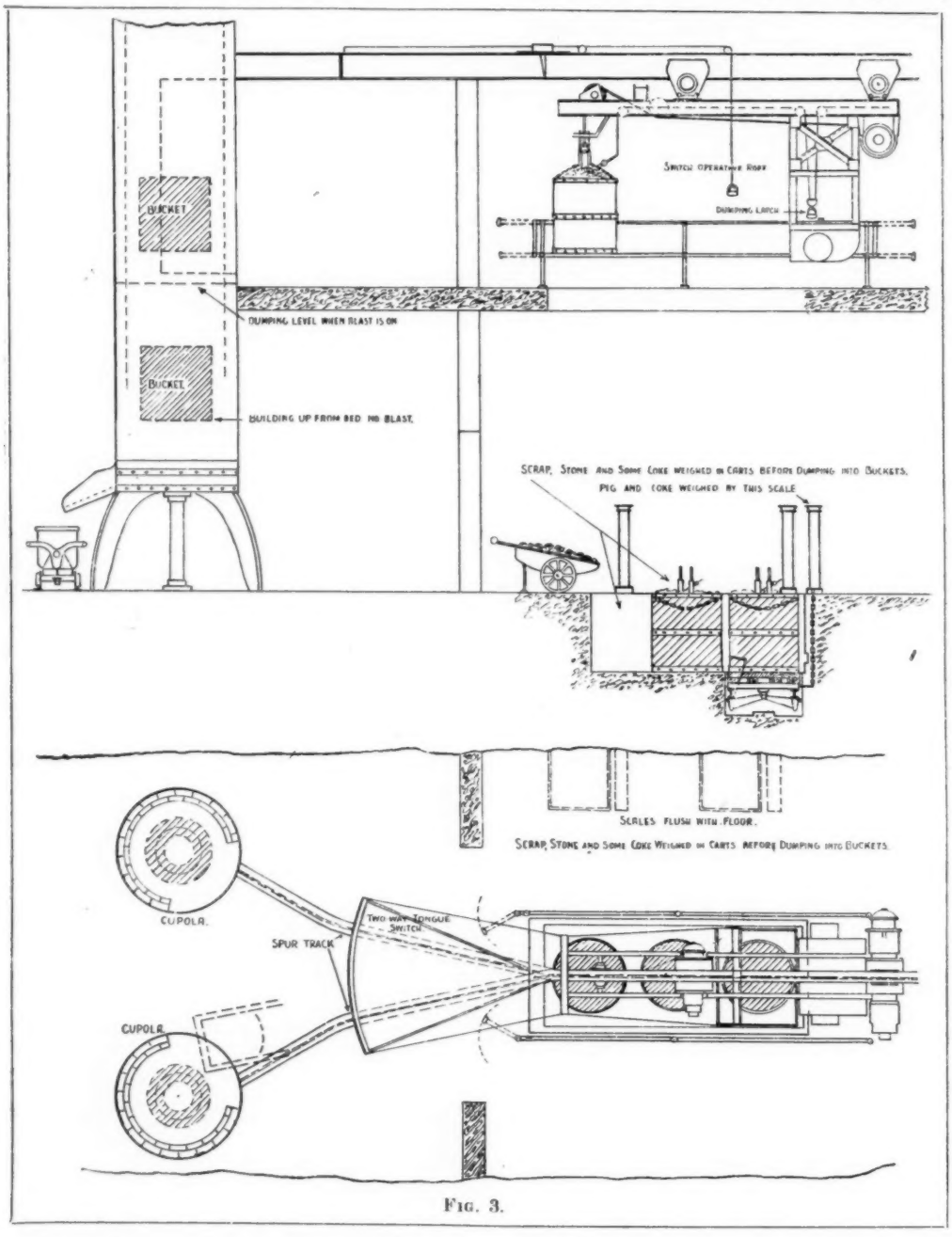

BUCKET
DUMPING LEVEL WHEN BLAST IS ON
BUCKET
BUILDING UP FROM BED NO BLAST
SCRAP, STONE AND SOME COKE WEIGHED IN CARTS BEFORE DUMPING INTO BUCKETS.
PIG AND COKE WEIGHED BY THIS SCALE
SCALES FLUSH WITH FLOOR.
SCRAP, STONE AND SOME COKE WEIGHED IN CARTS BEFORE DUMPING INTO BUCKETS.
CUPOLA.
SPUR TRACK
TWO-WAY TONGUE SWITCH
CUPOLA

Fig. 3.

for various values of standing charges proceeding. It will be seen that as the standing charges increase the range of economy for the less speedy lifting mechanism decreases.

One dominant fact is brought out by these curves, and that is:—*It is the very worst possible policy, particularly in hand-lifting machinery, to instal any other than a high-efficiency machine.* These curves compare normal working costs only, and do not make allowance for the decreased safety and liability to breakdown, so very often found in the less efficient and badly made cheap type of lifting gear.

Sand Handling.

In general foundries where no automatic sand preparing and conveying system is in use, the electric overhead runway (or when suitable the hand overhead runway) can be arranged to good advantage for delivering new milled sand, or taking out shaken out sand by means of electric travelling hoists, and automatically-operated grab, or tip-and those which must traverse variable routes the battery truck is finding a continually widening field of application.

The effect of good internal transport in the foundry is very pronounced, eliminating delay, removing strenuous operations, and allowing moulders to devote more time to actuate production, and to expend their energy in the most economical manner. Sand and molten metal are handled with facility, charging is reduced to a science, castings are removed to the dressing or fettling shops, and sand blast, with ease and facility, and moulding boxes and tackle are brought into use, and also rapidly removed, and properly stored when out of use. A foundry equipped with labour-saving devices for conveying materials can command the best class of labour, as moulders, and others, are able to earn a better wage with less fatigue. The facility with which all waste material can be removed means cleaner foundries, and reduces waste to a minimum.

FOUNDRY COSTS FOR ONE MONTH, 1925.

Weight of good castings made.				Metal cost.			Direct wages.			Oncosts.			Total cost.		
T.	C.	Q.	Lbs.	T.	C.	Q.	Class.	£	s.	d.		£	s.	d.	
93	2	1	20	130	12	1	Moulding	310	9	7	Melting	119	3	3	
				Less shop Scrap			Coremaking	58	11	1½	Dressing	82	4	5½	
				30	2	2									
				124	5	3									
93	2	1	20	456	10	0		369	0	8½		201	7	8½	

ONCOSTS.

A.—INDIRECT LABOUR.			
(1) Supervision in Foundry		16	16 0
(2) General labouring in foundry			
(3) Sand preparation for moulders		57	5 10
(4) Pouring labourers			
(5) Shop cleaning			
(6) Test bar experiments			
(7) Pattern store keeper		14	14 3
(8) Maintenance—plant and patterns		8	14 0
B.—GENERAL STORES, ETC.			
(9) Stores supplies—Core shop		5	17 0
(10) ,, ,, —Foundry			8 9
(11) Coal dust, blacking, etc.		13	6 10
(12) Shop heating			
(13) Core stove fuel		11	8 4
(14) Sands		15	19 9
C.—POWER COSTS		8	2 6
D.—WATER COST		1	2 0
E.—REPAIRS, RENEWALS AND MAINTENANCE			
F.—LOOSE TOOLS		3	7 7
G.—STAFF AND MANAGEMENT		29	13 0

Weight of good castings made.				Metal cost.			Direct wages.						
T.	C.	Q.	Lbs.	£	s.	d.	£	s.	d.	£	s.	d.	
93	2	1	20	456	10	0	369	0	8½	388	3	6½	1,213 14 3

PERCENTAGE OF TOTAL COST.

Metal cost	37.6%
Direct wages	30.4%
Total indirect wages	16.5%
All other expenditure	15.5%

COST OF GOOD CASTINGS=£13 5s. per ton.

buckets, and some foundry managers of high repute rely upon this system. Many good examples of this method of sand transportation from the sand plant to any point required in the foundry, as also to feed special storage hoppers serving the core departments and light foundry, using in conjunction with electric travelling hoist a grab of the combined hand and self dumping type arranged for discharge when suspended by means of hand operation, or cord, or automatically, can be found in use in this country.

Battery Trucks.

The electric battery truck, as a locomotive alone, for hauling trailers, with fixed or lifting platform, is a good distance-hauling medium for the periodic movement of unit loads, and serves its purpose well for traffic between buildings some distance apart, and when moving material of a character not adapted to the fixed conveyor economies, its use is dictated for widespread distribution to many points, great variety of materials, or where the movement is too light to support the larger fixed equipment. For comparatively long movements,

Something more must be done in Great Britain to cut down productive costs, and it is the duty of all foundrymen to look closely and quickly into the means of securing a greater output at a less cost. Everything required for economical lifting and shifting can be bought in Great Britain; so buy British.

The examination, as detailed above, of a monthly cost sheet of a small or medium-size general foundry engaged on light and medium work, with some repetition moulding machine work, having an output of some 93 tons of good castings per month approximately, at a shop-door cost of £13 5s. per ton, covering all internal cost, but no establishment charges, to be brief, on the usual lines of a foundry being part of an engineering business producing castings for its own consumption.

Under the heading of indirect labour there are "general labouring," "sand preparation," "pouring labourers," "shop cleaning," etc. These items figure out at £57 5s. 10d, or 12s. 4d. per ton of good output. It is apparent serious economies have still to be effected here by the introduction

of improved and additional material handling appliances.

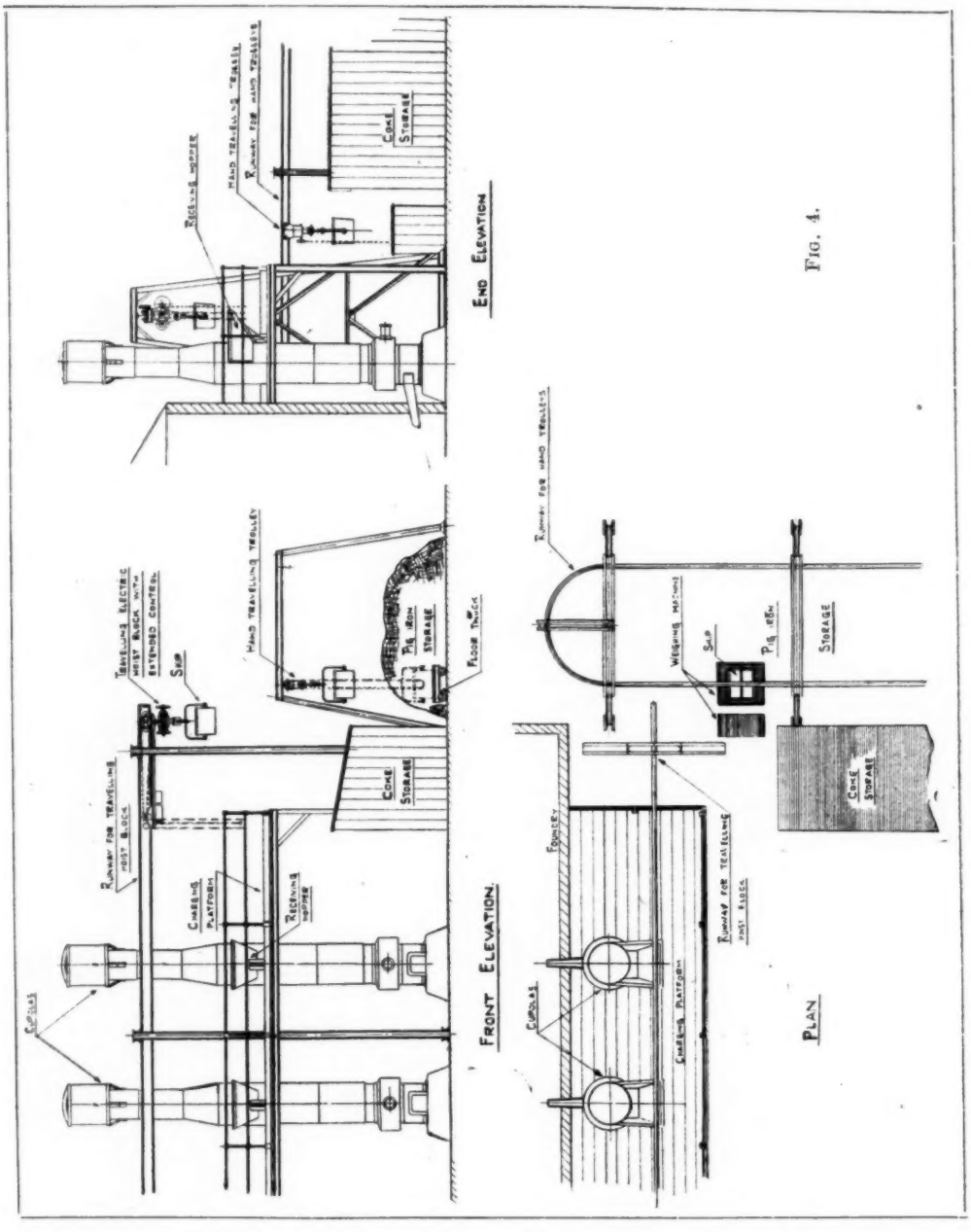
Now, take the melting cost, which also forms part of the oncost, this item figures at £119 3s. 3d., or 25s. 7d. per ton of good castings, in this is found £41 3s. 11d. for cupola attendance, or 8s. 10d. per ton of good castings, so that there is a total labour oncost of £98 9s. 9d., made up as follows:—

	£	s.	d.
General labouring			
Sand preparation	57	5	10
Pouring labourers			
Shop cleaning			
Cupola attendance	41	3	11
	£98	9	9

or 21s. 2d. per ton in bare figures.

These items really can be improved considerably, as also can the direct labour for moulding, which stands at £310 9s. 7d., or £3 6s. 9d. per ton, by the installation of more jib cranes of various types for the individual use of the mouldings, together with a sand preparing plant, and in one section, a system of light transporter cranes to allow of the whole floor area being used to better advantage.

The most serious obstacle to progress in this particular foundry is floor area, and it is realised that by allowing the moulders twice the working area they now have, so that the previous day's work could be shaken out and cleared without interfering in any way with a full day's moulding, this would allow of a greatly increased turnover, with very little additional operating expense.



Moulding appliances are not in the scope of this Paper, but if a portable auto sand cutter is to be used on the foundry floor it must have adequate crane service, as also does the portable type sand slinger, which also requires proper sand feeding, or it cannot be used to the best advantage; but foundrymen who have read the articles in the Press, and also the Papers read by Mr. Lane and others on "The Mechanical Handling and Preparation of Sands," have some idea of the importance of the various lifting and shifting devices involved in a proper sand system.

Here were shown some 30 more views of lifting and shifting appliances interesting to foundrymen.

Mass Production in the Foundry.

Now with regard to the strictly repetition foundry, things are very much different here from those prevailing in the general and jobbing

foundry, and the system employed needs to be more or less continuous. In the foundry equipped for rock-bottom cost repetition-production the moulds are usually poured as they move along a continuous conveyor; the men who pour devote their entire time and attention to the work.

As the flasks are poured they move along the conveyor to a shake-out or knock-out grating. Here they are knocked out by hand, a vibrating appliance, or a mechanical jar knock-out machine.

DETAILS OF METAL COST.

Pig-Irons	T.	C.	Q.	Lbs.	Per ton. £	s.	d.	£	s.	d.
No. 3	25	13	3	14 at	5	15	6	148	18	0
No. 3	27	4	2	14 at	4	1	0	110	5	9
No. 4	10	15	2	0 at	4	2	6	44	8	11½
No. 1	2	0	0	0 at	4	13	9	9	7	6
Own Scrap	31	11	0	0 at	4	2	6	130	2	9½
Bought Scrap	33	7	1	0 at	4	2	6	137	12	3
	130	12	1	0				£580	15	3
Less Shop Scrap	30	2	2	0 at	4	2	6	124	5	3
	100	9	3	0				£456	10	0

DETAILS OF MELTING COST.

	£	s.	d.
Labour—Cupola attendants	41	3	11
Fuel	55	2	0
Stores, Refractories, Limestone, etc.	13	7	4
Re-Lining Cupola and Plant Upkeep	2	10	0
Power	7	0	0
	£119	3	3

DETAILS OF DRESSING COST.

	£	s.	d.
Labour—Fettlers and Sand Blast Operator	61	10	5½
General Stores and Supplies	1	9	0
Power Cost	19	5	0
	£82	4	5½

The flasks are immediately available, and are used several times each day. Due to this rapid handling, less flasks are necessary. It has been said that sometimes the saving in flask equipment is enough to pay for the continuous equipment. From the knock-out grating the sand drops into a hopper; from this hopper it goes on to a conveyor that carries it to a screen. The screen takes out all hard lumps, sprues, gaggers, rods and nails, and ensures sand of uniform size for moulding. It "fluffs up" and cools the hot sand. Below the screen the sand passes over a magnetic separator, which removes all remaining metal.

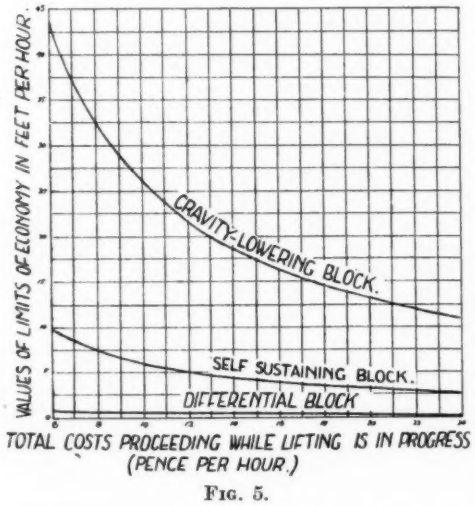

VALUES OF LIMITS OF ECONOMY IN FEET PER HOUR.
GRAVITY-LOWERING BLOCK.
SELF SUSTAINING BLOCK.
DIFFERENTIAL BLOCK
TOTAL COSTS PROCEEDING WHILE LIFTING IS IN PROGRESS
(PENCE PER HOUR.)

FIG. 5.

The sand now passes over a tempering belt, where it is wetted down, and then into a conditioning machine. This machine aerates, blends, and tempers the sand, and puts it into proper condition for moulding. The working part of the machine is a simple revolving cage. Sand is fed into this cage, and is thrown between the pins to break up all lumps, and give the sand a uniform consistency. The conditioned sand now goes to a central overhead storage bin. This bin has sufficient capacity so that the sand becomes properly seasoned before it is used. From this bin a uniform flow of sand is delivered by an automatic cutting feeder to a conveyor that distributes the sand to the bins above the moulding machines. This continuous process is in use for not only light, but also medium size work, and it is claimed in America as an example of its efficiency that 23 men easily do the work of 65 men in two-fifths of the space previously employed.

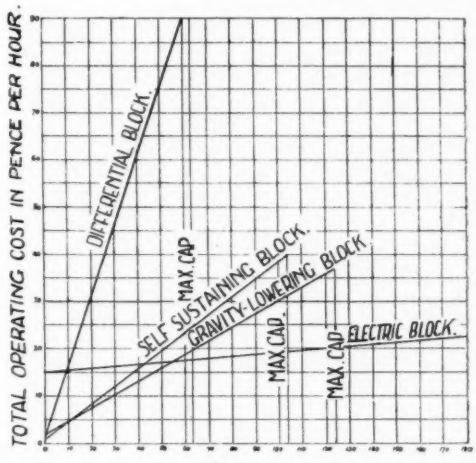


FIG. 6.

Conveyors.

Much progress has been made by the use of conveyors in this country during the last few years, the gravity conveyor by itself having come into use by leaps and bounds, and great economies and increased output have been effected by their use. Finally, reference should be made to the continuous core-drying stove, several examples being in use in this country. Conveyors set a pace of working that ensures a uniform rate of production, and as is well known have helped much in reducing the cost of production in many lines of repetition foundry work.

Conclusion.

The author desires to express his gratitude to his friends Mr. John Lucas and Mr. Clarke for their great help to him, and the team spirit shown in connection with this Paper during a period of great pressure, and also acknowledge his references to the Paper read by Mr. Primrose, of Falkirk, and also for useful extracts from THE FOUNDRY TRADE JOURNAL, and also to his colleague, directors of Messrs. Herbert Morris, Limited, for placing at his disposal much information of interest.

DISCUSSION.

MR. RUSSELL believed the audience was considerably bewildered at the ground the Paper covered and the number and variety of appliances nowadays available. He was particularly interested in the cupola charger, this being one of the foundryman's crucial problems to-day; the cupola charger tended to a better control, as under the old style of things the man was out of sight on the cupola stage. He was quite sure it would be a boon if the charges could actually be weighed on the ground. He would have liked Mr. Moore to have enlarged on the two runway system of cupola charging. A point that always reacted against the use of the average pulley block in the foundry was that (if the job was a fairly large one) the chains had the action of damaging the moulds.

He was sorry that the lifting gear manufacturers had not yet originated a crane whereby the gears were all in, or controlled from a gangway. Personally speaking, when this proposition had been mentioned to the crane manufacturers, he had always been informed that the loss of efficiency when the chains were all in a gangway was very serious. The two-speed block referred to by the author was an interesting device. He would like to be assured of its safety. An electric block, shown on a slide, was, from his own experience, a most efficient tool. He had one at work in his fettling shop for 5½ years, and it was surpris-

ing how little trouble it gave. For handling foundry loads up to 2 tons he had not the slightest hesitation in endorsing the claims made for the electric pulley block.

The figures given relating to the weight of materials handled per ton of castings produced were astounding, but they were obtained from so many sources that their accuracy could not be doubted.

Respecting the particulars given of foundry costs, he was not quite sure what these covered without personal reference to the figures, and, although they were extremely interesting, it was quite possible they were taken out in a different manner from what he was used to.

In reply, Mr. Moore said he agreed that with regard to travelling gear in the foundry there was something yet to be done, but very much progress had already been made in this direction, and foundrymen's views as to what was best for their own specific cases varied greatly. He assured Mr. Russell with regard to the two-speed lifting block that there was no doubt whatever with regard to its safety. (Mr. Moore enlarged on the design of the block.) With regard to the oncost figures mentioned, various foundries made up their figures in different ways, but the same facts had to be faced. He was pleased to hear of Mr. Russell's experience with the electric pulley block. He (the author) was sure that it had a greater future than any other lifting gear, and in these days when production costs must be lowered, the great aid would be found to be the electric pulley block.

Mr. Pemberton said that he had been very interested in what had been shown. It had taken them from coolie labour to shipbuilding cranes. The cost of wages undoubtedly played a big part in present-day costs. Mr. Moore had raised one point with regard to cupola charging apparatus, *i.e.*, "15 tons per hour, the charging now being done by six men, which was previously done by 24 men." That meant that each man would be handling about 2½ tons per hour, which did not seem a great advantage. Mr. Pemberton had in mind his own cupola, doing 10 tons per hour, handled by two men, charged from the floor, and he would like a private discussion with Mr. Moore as to what would be saved by charging up with an overhead runway.

All data to be made available.

He (Mr. Pemberton) advised foundrymen that if they were installing overhead appliances to discuss the matter only with the experts, and to remember that it was in the mutual interest of the supplier of the plant and the user that the user should put all his cards on the table when putting his proposition up to the supplier. He thought that the author should have dissected his Paper, and given it to them over a series of Papers.

Mr. Moore, in reply, pointed out that with regard to the use of cupola charging apparatus and the 15 tons per hour now being charged by six men, and which was previously handled by 24 men, that Mr. Pemberton had perhaps not realised that the figures mentioned covered not only charging, but all the actual work done from the removal of the material from the railway trucks, staging it, weighing, and the whole of the work up to the actual charging into the cupola.

Pulley Block Chains.

Mr. Cox said that what appealed to him most in lifting gears for foundries was not so much as the utilitarian point of view but the safety factor. He thought that if cranes could be operated with the chains at the side it would be much better—that is, if the control could be removed further away from the molten metal it would be a distinct advantage, and, furthermore, the blocks should be guarded so that they were not subject to heat.

Mr. Bunting thought that the manufacturers who specialised in hand-hoisting tackle should be able to provide a device which would allow the men to stand further away from the molten metal.

Mr. Moore said he was not clear as to whether Mr. Cox was referring to hand or electric lifting gears, but in any case he (the author) was sure the requirements of the case could be met without difficulty; but it was a question of the manufacturer having a proper knowledge of the conditions to be met, and the same remarks answered the question of Mr. Bunting.

Mr. Stevenson asked the author for advice on the lubrication of foundry machinery generally. It was known throughout the trade that the foundry machinery was the most neglected of any section. There was no doubt that when new machines were supplied to the foundry they were fitted with oil holes, but these very soon became blocked up, and he wondered if the author could give them any information on the best method of providing lubrication of foundry machinery.

Mr. Evans said that the productive moulding costs were nowadays so low that little further could be done in this direction, and the foundryman was now forced to tackle this handling proposition. It had been forced on him that the highest costs were those entailed in handling material. The moulding costs were satisfactory, but many had fallen behind in their methods of handling. He had found the electric battery truck almost invaluable in solving some of his material handling problems. Finally, he asked if there was yet a magnet crane available which could work on an A.C. circuit.

A hearty vote of thanks was accorded the lecturer.

Catalogues Received.

Machinery for Cutting Street Main Pipes.—Messrs. Weston, Shipley & Weston, Limited, of 72, Rutland Street, Leicester, have tackled the problem of drilling and tapping holes in and cutting the ends off gas and water mains, and have designed and placed upon the market a range of five sizes. The range covers pipes from 6 to 36 in. dia. The standard "Kut Out" machines are hand-operated, but a portable power attachment can be supplied. The catalogues under review are in the form of single and four-page leaflets.

Core Binder.—Several of the stockists of Glutrin have sent us a copy of a 12-page booklet which, after setting out the claims of the compound, detail the *modus operandi* first for steel castings, then as a partial subsitute for oil, then for grey iron, and finally for non-ferrous alloys. We believe the setting out of definite recipes is desirable, as it tends to reduce initial experimenting costs, and forms an excellent jumping-off ground.

Safety Goggles for Industrial Workers.—Perhaps we approach the review of this catalogue from a slightly biassed standpoint, as we have ourselves been rendered temporarily blind by the use of unsuitable glasses. At that period, however, no suitable glasses were on the market, but to-day reliable goggles are available. Some excellent examples are described and illustrated in a 12-page art catalogue which has been sent us by Mr. H. G. Sommerfield, of Charterhouse Chambers, Charterhouse Square, London, E.C.1. The first examples illustrated refer to fettlers' goggles, where it is pleasing to see that comfort, fragility, ventilation and dust-proofness have received consideration. For welding, the additional property of heat and electricity non-conductivity has been incorporated, together with a complete exclusion of side light. For melters, cobalt blue glasses are listed, though we feel that every pair sold, especially for electric-furnace work, should be labelled in a manner similar to that used in connection with dangerous drugs, but instead of the word "poison" these glasses should be designated "dangerous." The advantages of glasses which effectually prevent the passage of dangerous actinic rays should be emphasised wherever possible. These are also listed, but to our mind are insufficiently stressed. We have, however, already confessed to a prejudice. The latter half of the booklet is devoted to face shields and helmets for welders and sand-blast operators, of which some good models are illustrated. The booklet should be procured and filed by all who have humanitarian principles at heart.

The North British Locomotive Company, Limited, are to supply the Cordoba Central Railway Company, Limited, with fifteen 4.6.4. type superheater tank locomotives, and Kitson & Company, Limited, have orders from the same railway for five 4.6.2. type superheater engines and double bogie tenders.

Aluminium-Alloy Permanent-Mould Castings.—VI.

By Robert J. Anderson, B.Sc., Met.E., D.Sc.*

Manufacture, Design and Gating.

Many engineers and purchasers of castings are not familiar with the complexities of the aluminium-alloy casting industry nor of details of the methods employed in the production of castings by the three main processes. As stated in a previous article, the qualities and properties of sand, die, and permanent-mould castings are essentially different, and this is due in the main to fundamental differences in the mode of manufacture. Correct design is an important factor in the successful production of permanent-mould castings, since design is closely related to the method of gating and type of mould made for pouring the parts. In the aluminium-alloy field, the merit of the permanent-mould-cast product has not generally been brought to the attention of the great field of possible consumers, and new consumers in considering the use of such castings should bear in mind that impractical design may preclude their use, since some designs are not feasible to cast in permanent moulds. The more impractical the design, particularly in permanent-mould work, the greater the cost of producing the casting, and the worse the casting will be from the point of view of its mechanical properties and freedom from porosity and other usual foundry defects.

Essentials of the Permanent Mould Process.

As explained briefly in a previous article, a permanent-mould casting is made by pouring a liquid alloy into a previously heated and assembled mould, dissembling the mould, and removing the casting. The usual mould is made of grey cast iron, while the cores are generally alloy steel, *e.g.*, ordinary nickel steel, chrome-vanadium steel, or other special steel. The mould is parted in two halves, and the cavity is machined out to give the shape and contour of the outside of the casting. The cores are machined to size and shape so as to give the desired contour to the inside of the casting (if hollow). The general features of permanent moulds of several types have been discussed by the writer and M. E. Boyd,[1] and those of permanent moulds for aluminium-alloy piston production, also by the writer and M. E. Boyd.[2]

Moulds may be operated entirely by hand, *i.e.*, opened and closed, or they may be semi-automatic, the opening and closing being done by mechanical means. Cores are usually set by hand, and the pouring is done by hand. The mechanically operated mould increases production markedly. Moulds are heated with burners until they attain the proper temperature, and the temperature of operation is largely dependent upon the rate of pouring. There is great need for definite temperature control of moulds, since many wasters are due to variation in this factor. The oil-cooling process which is applied to permanent moulds for making grey-iron castings may be a solution of the problem.

The aim in designing moulds is to secure a mould which will give a progressive freezing of the liquid alloy, *i.e.*, so that the gates freeze last. If parts of the casting freeze last, there will be sinks on the surface. In sand founding the casting may often be gated at any special places desired in order to take care of contraction and ensure proper feeding. In permanent-mould work, the gate must be placed in the parting line of the mould. Risers can be used freely in sand work to feed heavy sections, but many times a riser cannot be used in a permanent mould, although the need exists. Cracking can often be prevented in sand practice, and cooling rates equalised by the use of chills, but chills have not worked well in permanent moulds. In order to equalise cooling rates in the latter, the thickness of the mould at different sections can be varied, but then the mould tends to warp. Inserts of higher thermal conductivity than cast iron, *e.g.*, copper, have been used as chills in permanent moulds, but experience with them has not been satisfactory. In sand work, cracking due to hard cores can easily be remedied by using soft cores, but in permanent-mould work the cores are entirely rigid. Hence, in the operation of moulds, the cores must be extracted at the right time after pouring the metal; if left too long, cracking will ensue or the casting will stick to the cores, or both; if pulled out too soon, the casting may bleed or at least be damaged owing to its hot shortness at the high temperature.

Internal flanges and undercuts cause the permanent mould designer much trouble because the required coring becomes more complicated. Thus, taking an ordinary piston casting: this might be made with a three-piece collapsible core; if an internal flange at the bottom of the skirt is added, a five-piece core is necessary. Moulds must be correctly vented, since otherwise the sections may not fill properly. Venting in sand work is easily taken care of by using an open sand or employing the vent wire to provide gas exit holes at particular place. Venting can be readily done on the parting faces of permanent moulds, but in other places exit holes must be drilled through and many times it is difficult to decide how best to place such holes. Moreover, such vent holes must be kept open or they are useless, and this often slows down the operation of the mould. Permanent-mould castings are often gated, with the longest dimension in a vertical position, the parting line being in the middle of the casting, but other methods are used. In some cases after a mould is made, the casting will run satisfactorily only if the mould is tilted at some angle. In sand practice, the natural way to mould flat work is with the long dimension in a horizontal plane, but in permanent moulds this dimension should be vertical.

General Aspects of Design.

Impractical and unnecessarily complicated designs are a source of trouble and expense both to consumers and manufacturers of castings. At the present time, permanent-mould-castings producers are having difficulty in handling castings which were designed especially for production in sand or by die casting. If castings designers were aware of the possibilities of the permanent-mould product, their designs could be made such that the castings could in many cases be readily produced in permanent moulds. Where castings are designed especially for sand founding or die-casting production, it is often very difficult to make them in permanent moulds at a competitive price.

Each particular casting, when made in permanent moulds, is, more or less, an experimental proposition until gating and design are correctly worked out and correlated, and it will always save trouble if the prospective customer will confer with the engineer of the permanent-mould-casting manufacturer before the final design of a casting is decided. Suggestions by the producer of castings as regards uniformity of sections and other important items will, in most cases, be invaluable to the customer in designing a casting for his requirements that can be made most economically and successfully in a permanent mould. The writer has seen many designs of castings which would make excellent permanent-mould production jobs if altered slightly from their original form, but which, as designed, were practically impossible to make by permanent moulding.

Draughtsmen and designers should view their designs from the point of view of the castings producer as well as from the point of view of the application of the casting, with the object of saving trouble and expense for both purchaser and vendor. Correct design, from the point of view of manufacture, is of great importance in securing

* Consulting Metallurgical Engineer, Cleveland, Ohio, U.S.A.

[1] R. J. Anderson and M. E. Boyd, "The Production of Castings in Permanent Moulds," Paper before the Institute of British Foundrymen, Newcastle-on-Tyne meeting, June, 1924.

[2] R. J. Anderson and M. E. Boyd, "The Production of Aluminium-Alloy Pistons in Permanent Moulds." Trans. Amer. Foundrymen's Assoc., Vol. 32, part 1, 1925, pp. 226-286.

a quality product. Castings with uneven form and with thick and thin sections in contiguity may contain contraction defects despite anything the permanent-mould founder can do, owing to the different rates of cooling of such sections. As mentioned above, whereas in sand founding chills can be applied to heavy sections to regulate cooling rates or risers can be attached to feed up sections which may contract heavily, this is often impossible in permanent-mould practice. Hence, the purchaser can best serve his own interests by seeking the advice of the manufacturer in the matter of design and adhering to practical and sensible designs; otherwise, he runs the risk of getting an inferior casting and one which is not representative of the quality possible of production by the manufacturer.

Invariably, when new designs are evolved, advice should be had from the castings manufacturer, and his advice as to methods of gating should be accepted implicitly. The most important factor in the cause for increased costs in the production of permanent-mould castings lies in the attention and care given by manufacturers to mould designs and gating methods which will ensure the production of sound and reliable castings. In most cases where contraction defects and unsoundness arise, the designer is partly responsible, and it is the duty of the founder to bring to the attention of customers the necessity for correct and practical designs. The permanent-mould manufacturer has passed through a period of development which has established in part the fundamental principles of successful castings production by this process, and these manufacturers are doing everything possible to turn out a quality product. Large sums of money have been spent on mould design and gating methods, and the permanent-mould manufacturer is compelled, from self-interest, if nothing else, to continue efforts in the direction of general improvements.

Gating Methods.

Gating methods in permanent-mould work can be discussed only in a general way here, since each casting presents a problem of itself. The aim of the permanent-mould caster is to use as simple a gate as is possible, and in order to minimise the amount of scrap produced in the form of gates and feeders these parts are made as small as is possible and consistent with the production of sound castings. Even and uniform rate of flow of the alloy into the mould is one of the prime requisites of a good gate. This is due to the desire to overcome inequalities in pouring rates which are due to the personal element and cannot otherwise be controlled. Tendencies in gating have changed somewhat since the question was discussed a couple of years ago by the writer and M. E. Boyd.* At the present time the tendency is to gate directly at the juncture of the side and bottom, using no cross feeders. Some manufacturers use a high riser situated in the line of the main gate and between the point of ingress of the alloy at the gate mouth and the body of the casting. Others have dispensed with risers wherever possible, aiming to feed from a single gate and regulate the flow of alloy into sections of different thicknesses by venting. This latter method presents great advantages in reducing the amount of scrap owing to gates and feeders, but involves difficulties in the proper placing of vents.

Some gates which have given excellent results seem generally wrong from the point of view of filling the mould, and there is still much to be learned about the fundamental principles of gating. In any case, a gate which may give good results on one casting will not give good flow of alloy in another ,and in some cases will even prevent proper filling. The position of attachment of the gate in the case of castings having regular and simple form is usually not important, but with more complicated parts having bosses, lugs, webs, flanges, and other irregularities the gate may well be placed at a central position with even distribution of such irregularities on either side. In any case, the best method of gating is often not attained, but the caster must be satisfied with a gate which will give satisfactory results. Many patents have been taken out covering designs of moulds and particular methods of gating. The gating of permanent-mould castings is a question which cannot be discussed in a very definite way, and the problems involved are solved by the method of trial.

* R. J. Anderson and M. E. Boyd, *op. cit.*

Book Review.

Industrial Furnaces, Vol. II. By W. Trenks. Published by Chapman & Hall, 11, Henrietta Street, Covent Garden, London, W.C.2. Price 27s. 6d.

Unlike Vol I, the present book, which is complete in itself, does not contain much of a theoretical character. The Professor has endeavoured to give the English-speaking public an unbiassed treatise on the subject of industrial furnaces, and has rightly omitted to mention the names of the manufacturers whose plants he describes, and refers inquirers to the advertising columns of the technical Press and similar sources. The first chapter is devoted to types of fuels, and a useful table is incorporated giving their properties. We were a little surprised, however, to find that coke has been omitted, while natural gas, a fuel unfortunately absent from Great Britain, is prominent. Inasmuch as the scope of the book is international, we deplore the continued use of the Fahrenheit temperature scale.

The second chapter—"Combustion Devices for Gaseous Fuels"—is somewhat unique in character, as it treats of large and small gas furnaces in much the same way as one would expect a book on oil furnaces to treat of the burners, which subject is dealt with later on. The third section extends the subject to embrace solid fuels, but it does not deal specifically with everyday plants, such as crucible holes or cupolas. The author rightly devotes much space to combustion devices for powdered coal. The chapter winds up with a very complete section on electric heating elements. Well over 100 pages and diagrams are contained in this chapter. Chapter III is devoted to temperature control, and many apparati are described and illustrated, whilst the next relates to the control of atmosphere. Here again apparatus for accomplishing this with air and gas and air and oil mixtures are described. When it comes to solid fuel only one diagram, that of sheet furnace, is given. We would have liked to see some reference to the obtaining of a reducing atmosphere by the introduction into the combustion chamber of an auxiliary supply of heavy oil or bituminous coal, which preferentially takes care of the excess air. That the author is aware of this action is evident by a reference to oil-spraying of parts before reheating in an electric furnace.

Labour-Saving Appliances are dealt with in Chapter V, and being an American publication, this will be read with interest by British readers, as it is customary to hand the palm to the States for work of this character.

A very interesting study in fuel technology is given in Chapter VI under the caption "Critical Comparison of Fuels and of Furnace Types." The advantages and disadvantages of many types of fuel are tabulated for ready reference.

The final chapter is one dealing with the "Selection of Fuel and of Furnace to Suit Plant Conditions." The Professor has thought it desirable to reprint a questionnaire which originally appeared in "Fuels and Furnaces," and we not only endorse this, but believe the furnace-equipment manufacturers of Europe could very well standardise on some close approximation for their mutual good.

The book is a production of considerable merit, and whilst the treatment does not enable the foundryman and the steelmaker quickly to refer to it for help in trouble, it does present the subject in a logical way, and probably the adoption of any other system would lead to an "out-of-balance" effect.

Mr. H. Hornby, managing director of John Hornby & Sons, Limited, has been elected president of the Yorkshire Scrap Metals and Machinery Merchants' Association.

The Metallurgical Student in Industry.

"The Position of the Metallurgical Student in Industry" was the subject discussed at an important conference of metallurgical students which was held at the Birmingham University at Edgbaston during the period of the British Industries Fair. The points emphasised in the discussion were: (1) The most suitable technical training, both theoretical and practical, where that training could be carried out, and how far existing university courses might be modified in order to provide such training; (2) the most suitable mental attitude to be inculcated and the methods of affecting it; and (3) the most suitable methods whereby the student equipped with the requisite knowledge might be absorbed into industry.

Mr. C. E. Moore, who presided, pointed out it was a students' movement, organised and financed entirely by students. Discussing schemes of training, the Chairman mentioned these should, to some extent, meet the special needs of particular localities. Some universities and technical colleges trained almost entirely with this object; nevertheless, where so many men had to go overseas in metallurgical capacities, some provision for special branches might have to be undertaken, but the difficulty was to pick out from among the mass of branches of knowledge those branches that were of use for the training necessary to the competent metallurgist.

Dr. T. B. Crow (Birmingham) stated the first thing that counted was the works—a University metallurgical department should form an adjunct to the works. Some firms were inclined to regard the students as a body of self-centred people obsessed by their own point of view, who failed to realise it was the works that must come first, and that university training must be subservient to works requirements. Birmingham students did not hold the view, with which some industrialists credited them, that they could go into works and expect to receive a comfortable salary just because they happened to know, for instance, that Neilson invented the hot blast. They realised, he thought, very distinctly the sort of training metallurgists ought to have. With regard to the mental attitude by means of which they could regard works problems from the points of view of quality and quantity of output, this attitude could be brought about during pre-graduate training through the inclusion in their course of suitable subjects other than those directly related to metallurgy, and through the insistence upon six months' full-time works experience. They thought some time should be devoted to such subjects as accounting, costing, works organisation and administration, and the like. Not less important was the question of human relationship in industry.

Mr. M. E. Walker (Birmingham) said that an extensive period should be spent at works prior to graduation, and suggested that the present period of three months, as was customary in Birmingham, should be extended to six months between the final examination and degree conferment. He laid stress upon the point that the value of works experience depended upon the attitude of the works staff to the student during the period. The question of the status of the student was a difficult one. Salary depended upon an employer's estimation of a man's value, but the employer might put this too low through a lack of appreciation of what the man could do for the firm's benefit. Some managers hardly realised the existence of trained metallurgists, as distinct from works chemists, and it was amazing, he added, to find how little some men knew of university life and training.

Mr. Llew. Jarman (Cardiff) said the existing conditions were not at all satisfactory. They considered that the long vacation period of three months should be spent in various works. He did not think it would be wise for a student to go to a works and merely look round; he should be given some definite duties to do—a job, for instance, such as that of a foreman. At the end of the degree course there should be adopted an apprenticeship system to enable the university-trained man to obtain practical experience. On no account, however, should the university-trained student enter the routine analytical laboratory of works.

Mr. Harper, referring to the question of mental attitude, said that certain works managers seemed to distrust the value of the actual experience of the student. It was sometimes found that certain students went into works and conveyed the impression that they knew everything and that the "man at the top" was a fellow who knew very little about the business. That sort of attitude created a prejudice in the mind of the works manager against the metallurgical student. On entering works the student must be prepared to show deference to the long experience of the works manager.

Mr. J. K. Gwilym James (Liverpool) pointed out it was almost impossible to obtain practical training at the university owing to the fact that no facilities existed, and this part of the training should preferably be undertaken in some works where a comprehensive programme was carried out. Unfortunately, owing to the present length of the university courses, most students had not the time to spend in further study, as the more serious actual business of earning a living began to become a little pressing. With regard to a correct mental attitude, it could be obtained only in the works. Briefly, this was the £ s. d. outlook.

Mr. H. A. MacColl (Manchester) explained that in Manchester they concentrated upon the academic side, and they favoured the view that the metallurgist should have a good scientific grounding. With regard to works experience, they did not think that a period of six months was sufficient. It was necessary, he thought, they should go through every department in a works.

Mr. J. Barton, Mr. G. Brooks and Mr. A. B. Winterbottom (Manchester) also spoke. The technical training of a metallurgist consisted of a study of the principles underlying metallurgical processes coupled with a general study of engineering and kindred applied sciences. Further, the course should include some training in administrative methods. The attitude of the student should be one of willingness to learn and willingness to work in co-operation with the practical man. Two broad alternatives were mentioned—an apprenticeship system and an appointment to a proper position as metallurgical assistant immediately. A man who satisfied the requirements already referred to was worthy of a fair living wage, and on this account the apprenticeship system was not to be advocated. A graduate's first position on the works technical staff would naturally be one incurring the lowest grade of responsibility. In this position he would gain experience of works requirements and so, in a short time, would be fitted to take a position carrying with it greater responsibility.

Mr. V. W. Davison (Sheffield) agreed that some form of works' experience should be incorporated in the training of a metallurgist. In former years it had been possible for students to obtain much experience during vacation. Specialisation in University courses, he added, should not be carried too far.

A Mode of Valuation.

Dr. R. S. Hutton (Director of the British Non-Ferrous Metals Research Association) emphasised the importance of a closer relationship between the University metallurgical departments, and pointed out that in Germany and the United States of America the value of this factor was realised to a greater degree than in this country. In order to maintain our proper position in the industrial world, he said, we must keep to the level of absorption of University-trained men that had been reached in these countries. Better material in the way of University graduates was being turned out in this country than in America, but our power of absorption was less. In the case of a large American electrical concern 400

University graduates were accepted into the works, and half of this number remained permanently in employment. He referred to an article written by an American writer dealing with the assessment of the value to industry of the manager and his various qualifications. Intellectual honesty was assessed at 100 per cent.; imagination came next with 35, followed by judgment 18, personality 17, knowledge 13, experience 12, and energy 5. He knew of many instances in this country of University-trained men who had made good, and by their success had made the paths of others more easy.

Dr. D. H. Ingall (Principal of Wednesbury Technical College) said the graduate received into a works was inclined to criticism, and it was important to realise that an employer whose methods were criticised would display but very little interest in the progress of a critical student. Let them remember that men in industry who were not graduates had reached their various positions through the hard school of practical experience. Very often methods and practices suggested by students had been tried and found to be unacceptable. He stressed the importance of personality, to which quality he would give 35 points.

Professor Turner said there had been a great advance in this country during the past 25 years in the recognition of the value of University-trained men to industry. At the time of the establishment of the department at the University of Birmingham there were no trained metallurgists available, and naturally none was employed in the Birmingham works. Now quite a large number of trained men were employed there, and the number was steadily increasing. One important thing that had been established in the district was friendship between the large manufacturing concerns and the University. They must remember that a man who was absorbed into industry from the University represented the University, and that he was working not only for his own good, but for the good of those who came after him.

The Student in the Foundry.

Mr. J. G. Pearce (Director of the British Cast-Iron Research Association) emphasised the view that the University must not be regarded as an advanced technical school, and he was opposed to the introduction into University training of procedure that tended to convey that impression. Alluding to the position of the ironfounding industry, he said it employed a vast number of operatives possessing great practical experience, but having had practically no technical training at all. But there was an intermediate grade of men who had passed into the industry from the council, secondary, and public schools, and who were engaged in the inspection of castings, and various other duties of that kind. The University graduate was generally employed as a chemist or metallurgist in works covering a pretty wide field, so that he had comparatively little to do with the foundry itself. That was regrettable. The need for scientific control in the foundry was becoming more and more insistent every day. But the kind of man who seemed to appeal to the foundry manager or director was a foundry engineer rather than a metallurgist. With regard to the question of practical training, he believed it was essential, and suggested the period of such training should preferably be before graduation, though a little training should be obtained after graduation. It gave an insight into works' life and discipline, and provided an opportunity for coming in contact with experienced workers. Further, it gave the student practical knowledge, which was necessary, and brought him to the notice of the employer, in whose power it was to give him a job. An employer did not care to engage a man of whose worth he knew nothing. He did not advise that they should remain in the University on research work after graduation, unless they were prepared to undertake such work permanently. The provision of bursaries should be encouraged; eventually they might expect employers to give maintenance grants. Training, he added, might be more of an engineering than of a scientific character.

Patching Patterns.

By J. M.

It takes a clever craftsman to patch a job well. The writer has a recollection of an alteration in the design of a square iron condenser—a type not so common nowadays—when the mould which was well advanced had to be considerably altered, and both patternmaker and moulder had to exercise great ingenuity. The cause of the alteration was a draughtsman's error, and had it been discovered earlier the pattern would have been altered.

Apart from drawing office alterations, mistakes are not quite unknown in pattern shops. The best workmen make them occasionally, and they are generally able to patch work quite satisfactorily and without much labour. If a part of a pattern has been undercut or a curved shape is much altered, in most cases it is best to rectify the error by letting in a piece of timber and recarving the shape. In addition to timber there are four kinds of fillings used in pattern shops, i.e., shellac, beeswax, putty and plaster of paris.

Putty is very seldom satisfactory. On all but very fine work it is used for filling screw countersinks, but for any other purpose it is a failure. It remains soft for a long time. It has one advantage as a filler of screw countersinks that, if the pattern has to be reconstructed at any time, the putty can be scraped out and the screw head left free. Pattern shops sometimes make the mistake of stocking a big quantity of putty, which, before it can be used, gets dried up. It is more economical even in large shops to obtain putty as required. It may appear to cost more when bought in small quantities, but it is not really so, as there is less waste.

Beeswax is very satisfactory for patching patterns as well as for filling screw countersinks. It carves easily, and a very smooth finish is obtained. It is very frequently used in connection with small standard pattern work. There is the disadvantage that, if a pattern gets heated, the beeswax may run, but, on the other hand, this is a very rare occurrence. Perhaps the best way of melting the wax is to hold the block over the pattern and use a hot metal rod.

Shellac is one of the most valuable materials used in pattern making. Not only does it make, when dissolved in methylated spirits, a waterproof varnish, but when all this spirit has been burnt off a good adhesive is obtained. Shellac is, next to wood, the best material for patching patterns. The most convenient way to use it is to make a shellac "stick"; a quantity of flake shellac is put into a tin or saucer, and a long screw or thin rod is heated and dipped into the shellac. The rod is again run through a flame and dipped, and the process is repeated until the "stick" is ½-in. or ¾-in. in diameter.

It cannot be said that shellac is easily worked with tools. The edge is soon taken off chisel or gouge, and it is really only possible to scrape the shellac. With care a very smooth surface is obtained. Shellac is exceptionally suitable for small patterns made of mahogany or teak, because it is always better to have a surface of uniform hardness.

In light casting shops, plaster of paris may almost be said to be a more important material than timber, but in the engineering pattern shop it has never been popular. In some engineering pattern shops plaster of paris is used for obtaining awkward shapes, but in most cases when such patterns are required for one-off jobs they are made as skeletons. Plaster of paris could be much more used than it is, however, for patching work. A certain skill in mixing it to the best consistency has to be acquired, and it takes a little longer time than shellac or beeswax to set sufficiently hard to be worked. As a matter of fact, when it is used, it is best to form it to the required shape when it is quite soft.

There are certain patent plasters obtainable that are very suitable for patching patterns, and for high-class work they are really admirable, the only objection to their general adoption for all kinds of jobs being, perhaps, their cost. For small standard work they are better perhaps than the older and better known patching materials.

A Glimpse into a Non-Ferrous Foundry.*

By J. D. Frame.

Introduction.

A lecture on this world-wide subject at any time seems interesting either from a historical point of view or from a study point of view. In order to mark the progressive steps of man, his early history has been divided into three periods, each being named after the materials chiefly used in them for supplying weapons, tools and ornaments. Thus there is the Stone Age, the Bronze Age, and the Iron Age. A similar development has been going on for some considerable time past with regard to bronze, but inasmuch as no class-term has ben invented in these very inventive times for the new variations of that most ancient and useful alloy, it is difficult to designate this fifth age by a new title, and so one must be content to consider it as a revival of the Bronze Age in a more advanced and more highly-developed form.

As the Stone Age, however, was divided into two parts, namely, the old Stone Age, when men simply chipped stones, and the new Stone Age, when they learned to grind and polish them, so perhaps it may be permissible to consider the present as the Newer Bronze Age. Nor is it altogether inapt so to consider it when there are many varieties of bronze which have been produced within the last forty years, possessing very distinctive features from the ancient alloys, and some very remarkable qualities as compared with them, and very numerous are the purposes to which these qualities are applied, superseding as they do in many instances iron, and even steel itself. These considerations and the knowledge of the great value of these alloys to the present-day engineers have been the means of some of their greatest achievements in modern engineering.

That metals are capable of uniting with each other to form a series of bodies having more or less the properties of their constituents has long been known, and probably this knowledge has been usefully applied from remote antiquity. The Ancients were acquainted with seven metals—gold, silver, mercury, copper, tin and lead. They knew and employed various compounds of antimony, arsenic, and zinc, although we have no evidence that these metals were known to them in the metallic state. Gold and silver, which occur in nature in the metallic state, were probably the first metals with which man became acquainted, and as other metals were discovered, especially copper, efforts would doubtless be made to alloy the base metal with gold, in consequence of the comparative rarity of the latter.

Iron, in meteoric form, is a native alloy of iron, nickel, and small quantities of other elements, said to have been used by Esquimaux and other tribes for making knives and other weapons. Copper is also occasionally found *native*, and to persons accustomed to melt the precious metals, they had no difficulty in melting copper and alloying it with gold and silver. The Latin word "Aes" in ancient writings sometimes signifies copper and sometimes brass, so the two metals are consequently confounded occasionally. Pliny, the historian of his time, says that copper was first discovered in Cyprus. The proper name for brass in those days was Aurichaleum, or golden copper, and it may be inferred that ores of copper and zinc were sometimes melted together, forming brass, as the metal named zinc was probably unknown until the sixteenth century. Pliny describes four different varieties of what was known as Corinthian copper: (1) White in colour, it resembled silver in lustre, and contained an excess of silver; (2) red, in this kind there is an excess of gold; (3) in this kind gold, silver and copper are mixed in equal parts; and (4) this variety was termed Hepatison, having excess of copper, giving to it a liver colour, which gives it its value.

Copper was used by the ancients for many of the purposes to which it is put by the moderns, but the art of making tempered articles in copper —such as the ancients made—has been lost, and has baffled the efforts of scientists to regain this lost art for the last two centuries. An American is supposed to have found this ancient formula on a rubbish heap, but time will reveal the truth of this or otherwise. The alloys of copper with tin were used in various proportions; thus bronze for statues were composed of 100 parts copper, 12½ tin; another mixture, 100 parts copper, 10 parts lead, and 3 to 4 tin. The arms of these ancient warriors were often made of bronze which was rendered hard by a process of hammering, then heated and cooled slowly.

Tin was in common use in the time of Moses. It was doubtless Phœnicians who supplied the Egyptians with this metal, which the former obtained from the Scilly Isles and Cornwall. Cassiterous or tin is mentioned by Homer in the time of Pliny as being used for coating the interior of copper and brass vessels. Mercury was used by the Romans for alloying with gold and silver to form amalgams, which were used for gilding and plating as at the present time by laying the amalgam on the base metal and subsequently volatising the mercury with heat, leaving a thin coating of precious metal on the article. Lead was well known to the ancient Egyptians and Arabians as well as the Romans. Large quantities of lead were obtained from Spain and Britain. Sheet lead and piping were used for similar purposes to those which are employed at the present time. A mixture of lead and tin was also used as solder. Iron was known in very early times, but in comparatively small quantities, being obtained from meteoric stones or easily reducible oxide. Moses speaks of iron being used for swords, knives and axes, which seems to imply that steel was known at that early period.

Homer represents warriors as armed with bronze swords and never as using iron weapons. Achilles proposes a ball of iron as a valuable prize to be contested for in the games, which showed its scarcity during that period. That the Romans were acquainted with the hardening and tempering of steel there is abundant evidence. Thus the ancients knew the six malleable metals and their alloys, but they left us scant information respecting the method of extracting them from their ores. It is probable that only those ores of a simple character, or those readily acted on by reducing agents were employed, unless the appliances at their disposal and their general chemical knowledge were superior to what known facts warrant us believing. It has to be admitted that modern science has to be thankful for even such knowledge as has been handed down by these early historians.

That brass was known to the ancients is beyond dispute, but its direct preparation from copper and zinc is an invention of modern times. With the exception of iron, there is no product of man's industry that is earlier spoken of than brass, but the words thus used in all probability referred to bronze, an alloy of copper and tin. The brazen serpent in the wilderness, the brass vessels of Solomon's temple, and the so-called brass armour of ancient Greece and Rome were all doubtless bronze.

Bronzes of the Ancients.

The bronzes of the ancients varied considerably in the proportions of their ingredients, for in the main copper and tin only were used, according to the purposes for which they were intended. Thus modern chemical analysis shows that ancient bronze nails contained 20 parts copper, 1 tin; soft bronze consisted of 9 copper, 1 tin; medium bronze, 8 parts copper, 1 tin; hard bronze, 7 parts copper, 1 tin; and mirrors, 2 parts copper,, 1 tin. The bronze weapons and tools of the ancients contained from 8 to 15 per cent. of tin. A Roman sword-blade found in the Thames showed 85.70 and 10.02 tin, whilst another found in Ireland gave

* A Paper read before the Scottish Branch of the Institute of British Foundrymen.

an analysis of 91.39 copper and 8.38 tin. The bronze weapons of the Greeks and Romans have been found not only to be of the truest composition for ensuring the greatest density for alloying itself, but the cutting edges, by undergoing a process of hammering, were brought up to the highest degree of hardness and tenacity. Even to this day some of the finest steel is made in the simplest and rudest manner by natives of the Belgian Congo, Egypt, and other countries.

It is to be observed that most of the ancient coins were of bronze, a small percentage of zinc being added in some cases to improve the colour. According to analyses made by Mr. J. A. Phillips, the quantity of tin relative to copper varied very slightly even over the range of 300 years. The following are the proportions of copper and tin (the other ingredients being omitted):—

	B.C.	Copper.	Tin.
Alexander the Great	335	86.72	13.14
Philippus V	200	85.15	11.10
Athens	—	88.41	9.95
Ptolemy IX	70	84.21	15.59
Pompey	53	74.11	8.56
The Atilla Family	45	68.72	4.77
Augustus and Agrippa	30	75.58	12.91

Bronze pure and simple consists of a mixture of copper and tin in certain proportions, according to the purpose for which the compound is intended. Other metals, such as zinc, lead, phosphorus, manganese, silicon, may have been added without declassifying the product, which is still called bronze, provided that copper and tin are the chief constituents. The bronzes of France are known to contain nearly always four metals, namely, copper, tin, lead and zinc. It is also stated that some contain minute and variable quantities of nickel, arsenic, antimony and sulphur. It is the addition to bronze, pure and simple, of certain proportions of one or other of the metallic substances previously referred to that constitute the modern development of bronze manufacture, which has given us some of the most useful and at the same time some of the most remarkable alloys known. These comprise no fewer than twelve distinct products, all of which find their uses in connection with the practice of engineering. These are as follow:—Phosphor bronze, silicon bronze, manganese bronze, delta metal, phosphor copper, phosphor manganese bronze, phosphor lead bronze, phosphor tin, aluminium bronze, silveroid, cobalt bronze and vanadium bronze.

Phosphorus and Copper Alloys.

These alloys form the subjects for present-day consideration and investigation, each alloy functions in its own particular sphere. There are other bronzes which are used as substitutes for gold in cheap imitation jewellery, but they are in the main only variations of some of the bronzes. Attention was directed some years ago to the use of phosphorus in improving the character of bronze for various purposes, and eventually with very successful results. The action of phosphorus on copper alloys is principally due to its reducing qualities, by virtue of which the oxygen absorbed by the molten metal is removed or rather the oxides thereby produced are eliminated, and there is imparted to the metal that degree of homogeneity, strength and toughness which is peculiar to the chemically pure metal. The phosphorus, in producing these effects, is converted into cuprous oxide, which floats on the surface of the molten metal in the shape of a very fluid slag, whilst the superfluous quantity combines with the metal. This being the case, it is not desirable to add to the bronze a larger quantity of phosphorus than will suffice to reduce the oxide present. It is thought by some that the phosphorus itself imparts to the bronze the qualities of hardness and strength, and therefore the more phosphorus put into the metal, the better the results as regards hardness. This, however, is not the case inasmuch as hardness would be obtained at the expense of toughness.

The question of producing the various qualities of this class of metal depends, not so much on the quantity of phosphorus, as upon the correct proportioning of the various ingredients, phosphorus included. These alloys are formed by the addition of a small proportion of a compound of phosphorus-copper or from phosphorus-tin. However, great care is required in determining the exact proportions of the ingredients in making phosphorus-bronze alloys. A 15 per cent. phosphorus-copper to analysis is preferable. Phosphorus-tin, very often supplied, has too much lead alloyed with it, and makes it unsuitable for certain alloys in this group; also, it is inclined to rise in little white patches on the top of the casting through oxidisation of the compound. Phosphor-bronze was invented by Dr. Kunzel, of Blasewitz, Dresden, and was brought into practical use in this country early in 1873 by the Phosphor-Bronze Company, who have from time to time patented several improvements, both in respect to alloys and methods of manufacture. Phosphorus-bronze alloys are composed of copper, tin, phosphorus and other ingredients in definite proportions, and are made to be either as ductile as copper, as tough as iron, or as hard as steel, according as the proportions of the constituents are varied. The alloys used for rolling and drawing have very different proportions from those employed for castings, for bearings, and parts of machinery. The casting of the metal, owing to its greater fluidity when melted, is perfectly sound and homogeneous. Wherever strength, toughness, and durability are desired, phosphor-bronze is found to be far better adapted than gun-metal and brass, and in many cases than iron-steel. With regard to the applications of phosphor-bronze, it may truly be said that their name is legion. This remark applies in the main to most of the modern bronze alloys. Chief among their many applications is the manufacture of wire, rods, tubes, sheets, screw-propellers, pinions, slide valves, bearings, bushes, axle boxes and other parts of machinery exposed to friction. Phosphor-bronze possesses the advantage of not becoming crystalline under the action of repeated shocks and bends, and is therefore well adapted for making wire ropes, etc.

In the manufacture of castings from phosphor-bronze alloys, a new or clean plumbago crucible is desirable so as to avoid any admixture of other metals. It is best to place some small charcoal or char-dross in the bottom of the crucible, then add the copper. When this is thoroughly melted all charcoal or char-dross will rise to the top of the molten metal. Then remove the crucible from the furnace to the casting pit, where will be added the various ingredients. The charcoal or char-dross prevents oxidation, and should remain on the top of the molten metal until the casting temperature is assured, then skim and cast. The casting temperature is 950 deg. C. A very good practical way of getting the temperature is to blow with a pair of hand-bellows on the top of the molten metal. If ready for casting, a skin will come and go through the cold air coming in contact with the alloy. This indicates to the practical man that it is time for casting. For large castings, the moulds are thoroughly dried and dressed with a mixture of plumbago and thin clay water. Small work is cast green, and dressed with plumbago. These castings should come out with a very sharp and smooth surface, free from blowholes and oxide. In order to avoid segregation, it is necessary not to pour phosphor-bronze at too high a temperature, and to see that the alloy is well stirred, or, in other words, thoroughly mixed before casting.

Durability of the Metal.

Having referred to the great durability of phosphor-bronze under conditions of work, the author has made phosphor-bronze crosshead slippers to replace cast-iron slippers, which had only been in service three months when they were worn out. These same slippers have now been running four and a half years, and show little or no wear. Gun-metal slippers usually wear two years. A very interesting statement relating to phosphor-bronze was made forty years ago. A pair of slide-valves which had been taken out of one of the North-Eastern Railway Company's express engines, after six and a half years' working, during which the engine had run 261,182 miles between Newcastle and Edinburgh, they were taken out to replace the cylinders with a pair of a different type. The

engine was of the following dimensions: cylinders 17-in. dia. by 24-in. stroke, four coupled wheels 7-ft. dia., working pressure 140 lbs. per sq. in.; weight of engine in working trim, 39 tons 16 cwts.; weight of tender, 26 tons 4 cwts. Mr. Fletcher, the Assistant Locomotive Superintendent of the North-Eastern Railway Company of that period, stated that the slide valves in six and a half years had only worn down to the thickness at which they generally took out gun-metal slide valves, and that had it not been that they were putting in a pair of cylinders of a different type he certainly would have let them run longer, as he considered them quite safe, taking into consideration the great superiority of phosphor-bronze over gun-metal. The original thickness of these slide valves was 1 in., and they were worn down to ⅝-in. thick. Gun-metal slide-valves rarely exceed eight months' work when they are worn out. The cylinder faces were in excellent condition, the wearing being as it should be on the valves. Even to this day the locomotives of the L.N.E.R. Company, which have slide-valves, have them all made of phosphor-bronze. The composition is 86.5 copper, 13.0 tin and 0.5 per cent. phosphorus.

Some bearings which were giving considerable trouble in a rolling mill had bushes made of gun-metal which only lasted about five weeks before scapping. After replacement by phosphor-bronze the bearings have now been running eight months without complaint. Undoubtedly phosphor-bronze seems neglected by the consulting engineer or designer. They have proved to those engineers who have tried and experimented with these alloys to have been of great service and value to them in some of the great triumphs of engineering, which otherwise would have been complete failures. The beneficial effect of phosphorus on copper consists mainly in producing a material of definite closeness and of the highest possible degree of toughness and elasticity. These excellent qualities must not be attributed alone to phosphorus in the metal or only in a secondary degree, but are owing chiefly to the absence of oxygen, which by the energetic reducing action of the phosphorus is entirely eliminated.

(To be continued.)

Some Corrosion Resisting Finishes.

In dealing with corrosion problems one of the most important lines of development has been in the invention of special methods of surface treatment of articles, especially iron and steel articles, subject to corrosive influences. So numerous have these methods of treatment become that much confusion exists in regard to the nature of many of them, and it is the writer's object here to outline the essential features of some of the more important of these special processes.

The particular types of corrosion resisting treatments with which it is proposed to deal divide themselves into two main classes:—(1) Those that depend on the diffusion of one metal into the surface of another, and (2) those that depend on chemical treatments.

Diffusion Processes.

Of the diffusion processes, the most important are Sherardising, Calorising, and Chromising. Sherardising was the original process, and the story of its accidental discovery is fairly well known. The process consists essentially in obtaining a layer of zinc to diffuse into the surface of the articles treated. The usual way of doing this is to pack the articles in boxes with zinc dust, and then to heat the whole in a furnace at a suitable temperature for a length of time depending chiefly on the degree of penetration required. The effect of the heat treatment is to cause the zinc to diffuse, or penetrate, into the surface of the articles being treated, thus giving them a "casing" of high zinc metal, which has a very good resistance to corrosion under certain conditions.

The fundamental nature of Sherardising being understood, little further explanation is required in the case of Calorising and Chromising. The only essential differences are that in Calorising, aluminium powder is used instead of zinc dust, and in Chromising, chromium powder is used instead of zinc dust. Thus with Calorising the outer layers of the metal of the articles treated are impregnated with aluminium, and in Chromising with chromium, instead of with zinc as in Sherardising.

Some other materials are generally mixed with the metal powders used in such processes, but there is no need to go into these finer details here. All that need be further pointed out in respect to these processes is that the method of bringing the coating metal into contact with the articles to be treated may be varied. Thus a very similar effect to ordinary Calorising is produced by first spraying the articles with aluminium and then heat treating, instead of packing them with aluminium powder for heat treatment. This method is a fairly common method, especially now that the metal-spraying process has been brought to a reliable point of efficiency and certainty.

Similarly, a modification of the ordinary chromising process is to bring the chromium into contact with the article to be treated by electroplating the chromium on to the articles and then heat treating. However, no special advantage has been found for this over ordinary chromium plating, and it is only mentioned here to show the ways in which the process can be modified. A similar method of heat treating cadmium-plated articles was boomed in the U.S.A. a few years ago, but has, the writer believes, since been abandoned.

Of the processes mentioned, Calorising, with its modification, and Sherardising are those in most common use. The principal advantage of Calorising is, as the name implies (*c.f. calorie*), the increased resistance to the effects of high temperatures conferred upon the articles treated. Thus fire-bars, gas-burners, and similar parts are often calorised.

Chemical Processes.

There are innumerable chemical treatments used as finishes for metal surfaces, but all that the writer proposes to consider here are those of the Bower-Barff type and those of the Coslettising type. Both of these classes of finish have quite good corrosion resisting properties, and are fairly widely used.

In the Bower-Barff process the essential fact is the exposing of the iron or steel articles to superheated steam with a suitable reducing agent, such as carbon monoxide, to produce a protective oxide coating. The Wells process is a slight modification of this. The Gesner process, and its modification, the Hydraesfer process, also fall into the same class, in that exposure to steam at high temperatures is incurred, hydrogen also being introduced in these two latter processes, however.

The Coslettising process was the progenitor of a number of similar processes for investing iron and steel goods with a corrosion resisting phosphate layer. The essential is to dip the iron or steel articles in a suitable phosphate solution, as, for example, a boiling solution of phosphoric acid containing iron filings, for a prolonged period. The Parkerising process, which is one of the best known, of the modifications, introduces manganese dioxide into the phosphate solution as an oxidising agent.

In most of these processes thorough cleaning of the articles before treatment is necessary to success, whilst in some cases they are given certain finishing treatments, such as dipping in hot oil. There are, of course, numerous other processes of importance from the point of view of corrosion resistance, but these are for the most part well known or are of a nature as to require somewhat lengthy individual treatment. Thus there are the ordinary galvanising and tinning processes; the metal-spray process, to which reference has already been made; as also the more recent and very promising developments of chromium and cadmium plating.

W. H. S.

Major C. A. Mander, of Kilsall Hall, Shifnal, Salop, and a director of the Rees Roturbo Development Syndicate, Limited, is the new High Sheriff for Staffordshire.

Discussion on Mr. F. C. Edwards' Paper on "Castings Design."*

Mr. John Shaw said he thought Mr. Edwards had made a great mistake in giving his lecture there. He had come to the wrong place, he should have gone to a mechanical engineers or draughtsmen's association with it. If they were going to make a comparison they should make it with metal suitable to the casting they put forward. He had enjoyed the lecture, and said how essential it was that these things should be put forward. They were perfectly cognizant that there were varieties in design, and if they could persuade Mr. Edwards to go to the engineering institute it would be of very much greater service to them.

Mr. F. Darley said his experience was that stress was not in the arm but in the rim. He knew of a case in which they kept a casting in the sand for nearly a month to cool because they were so afraid of it. Whilst fettling it, it flew to pieces. They had twenty wheels to make and this was the first. He suggested that they split the rim, and it was split in three places, and what they learned in the cooling of that rim was a revelation. It was split with $1\frac{3}{8}$ in. cores, and during a certain part of the cooling each core opened $2\frac{1}{4}$ in. to $2\frac{3}{4}$ in. They left it in the sand three or four days, and it went back some $1\frac{3}{8}$ in. and some $1\frac{1}{2}$ in., and that illustrated took place in the rim. Before that they had experience on small wheels, and when they came out of the sand some had swells on between the arms. When they thought what took place during the cooling of castings well it meant practically about 4 in. in the rim, so they could consider what would have happened if it had not been split. He contended that a wheel of that class was practically without stress. He thought the double arm was a dangerous thing. He thought the lecturer was wrong when he said that stress was in the corner. He had known castings 30 ft. or 40 ft. long and he had never known any danger in the corner.

Mr. G. Edginton said crystallisation of metals ranged themselves in a definite form. By putting in a big bar they strengthened the corner very considerably. The worst people they came up against were the marine draughtsmen, who were tied down to lightness in section. By cutting his metal down to $\frac{1}{4}$-in. it gave him considerable strength. He gained strength by using the same silicon content. It was not a fair comparison to ask them to consider the load without they studied the breaking point.

Mr. Bradley thought the chief thing to be noticed was where they went from four arms to eight. If Mr. Edwards had put a double curve in he would have overcome his difficulty and the casting would have been quite as serviceable.

Mr. J. T. Goodwin said that undoubtedly design was a very important item, because the simplest alteration made for very considerable advantage in the foundry. There were numerous ways in which a casting could be made perfect, and what struck one foreman did not strike another. Many mistakes did occur, but they were fewer than they used to be. It was time there was some definite fixed education for the apprentice moulder. It was there and on these occasions, and on this class of work where education would stand the moulder in good stead. Such things as they saw that night would become more prominent in the education of the apprentice. Engineers were very apt to send a sketch out of the pattern shop which would be a source of continuous trouble to the foundry. By thickening it so that it would not break there again was not the way to look at it, but they should look at it as in the illustration of the bar under test. It was on these lines that men should think and re-design it. If that line of thought were carried out to a greater extent it would give them many more satisfactory castings than they had been having. He congratulated the lecturer upon the way in which he had tackled his job.

Mr. J. R. Hyde said they were beginning to learn what foundry difficulties were. It seemed to him that the actual moulder and craftsman was considerably benefited by these discussions because he was generally brought up on occasions of this kind, and having had the advantage of such a discussion as that he was heartened into giving an opinion. It seemed to him that this generation was wiser than the last as regarded the using of common sense in most problems. Most of the general tendency was to use brackets rather than run on the heavy mass. The strength of structural steels was pretty well understood and everyone was satisfied with them, but the material, cast iron, was always open to suspicion and they put plenty of material on it so as to be on the right side. He hoped they would apply what they had seen to any of their problems. The Americans cut the weight down to a ton per square inch.

Mr. Barker said that any reference to design by a moulder was more than his place was worth if he went to the patternmaker and insisted that pattern was wrong.

Mr. Pollard said any foreman or manager of a foundry could refuse to discuss with the moulder the merits of a casting. Mr. Edwards had served a good purpose in the things that he had put forward to them in his lecture. If they could get moulders on their feet they would learn a lot more from some of the lectures that he had heard.

Mr. Barker, remarked that they could do in steel what they could not do in cast iron, and *vice-versa*.

AUTHOR'S REPLY.

Mr. Edwards, in reply, said that whatever the Paper had been the discussion had been good. The line of thought was certainly a good one and one to be encouraged. Why should not moulders have as good brains as draughtsmen? Mr. Shaw said the lecture was more fitted for mechanical engineers than for foundrymen; they had in the Institute eminent engineers, and many who were interested in the drawing office. Though he might have made a mistake in not going to the mechanical engineers he was glad to know there were those present who were interested in it. Mechanical engineers read The Foundry Trade Journal and would doubtless be interested in some of the points raised. The lecturer dealt with points that affected the draughtsman. It was well to know that the lowering of the section test did confer a very decided advantage on the casting. Mr. Darley said the tension was not in the rim, but in the arms. He (Mr. Darley) said the rim was the first part cooled, being on the outside, but if the rim was very much heavier than the arms it did not naturally cool first. The part that cooled first was the part that had the least heat to lose. If they had a heavy outside rim it would naturally cool first. A 1/16-in. would cool before a $\frac{3}{8}$ in.

A Member: They do not understand those thicknesses in Sheffield.

Mr. Darley gave an instance where the rim had cooled first, even although the rim was 21 by 14.

Mr. Edwards said when it was put into the furnace it took the nature out of the metal (grey iron casting) and the rim in tension gave way.

Mr. Darley said he did not understand metals $\frac{1}{8}$-in.; they used heavier sections.

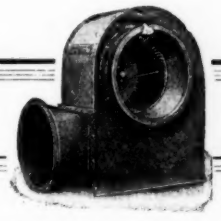
Mr. Edwards said it was stated that the tension was not in the rim but in the arm, and pointed to where the boss was only $\frac{1}{4}$ in. thick.

Mr. Darley said they had a research department in Sheffield and the results were quite opposite to those stated.

Mr. Edwards said it was as well to know as much about thin castings as thick ones. The crystallisation theory was now out of date—it was contraction. If Mr. Barker came across foremen who would not listen to what the men had to say, well, that was one of the reasons that was pulling old England down.

The Chairman (Engineer Lieut.-Commander L. Jackson, R.N.), said it was on that particular line, the line of thought, that they were going to advance. There were different schools of thought and they had had them expounded fairly well that night. He instanced the time when the paddle steamer and the screw steamer were contending for supremacy. People said how were they to prove which was which, and then the suggestion was made that they should get two ships of equal power and fasten them together by the stern. What was the result? The screw steamer towed the paddle steamer away.

* See Issue No. 493, Page 65.



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Trade Talk.

The Birmingham Railway Carriage & Wagon Company, Limited, have a contract for six sleeping coaches for the Buenos Aires and Pacific Railway.

Robert Stephenson & Company, Limited, of the Darlington Locomotive Works, have secured a contract for the building of six locomotives for the Uganda Railways.

"Aluminium, Where and How it is Made," was the title of an interesting lecture given to the Sheffield Branch of the Institute of Metals recently by Mr. G. B. Brook.

A lecture entitled "Experiments on the Deformation of Large Crystals of Iron" was given to the members of the Sheffield Metallurgical Chemists' Society recently by Mr. H. O'Neil.

Frank How & Company, Limited, of Stratford, London, E.15, manufacturers of "Trogon" lubricating oils, have a large contract for the supply of these oils to the Egyptian State Railways.

August's Muffle Furnaces, Limited, Thorn Tree Works, King Cross, Halifax, have appointed Mr. H. G. Sommerfield, of Charterhouse Chambers, Charterhouse Square, London, E.C.1, as their representative for the South of England.

By a majority of over two to one the Amalgamated Engineering Union has decided to join the proposed Industrial Alliance. The voting was: In favour, 70,695; against, 31,423; majority for, 39,272. It is understood that the Workers Union has also decided to join.

During the month Metro-Vick Supplies, Limited, Trafford Park, Manchester, and 4, Central Buildings, Westminster, S.W.1, will be moving into their new premises in Charing Cross Road. These have been entirely re-built, are very commodious, with very fine showrooms and trade counter, and architecturally are rather a striking feature in the road.

John Williams (Birmingham Sand), Limited, Icknield Square Wharf, Birmingham, now have a private railway siding connected with their quarries, which produce foundry moulding sands, and which adjoin the Great Western Railway. This naturally enables the company to load up and despatch at a much cheaper rate, as hitherto all material had to be transported from the quarry to the goods station for loading into trucks.

The Mirrlees Watson Company, Limited, Scotland Street, Glasgow, have an order from Michael Nairn & Company, Limited, Kirkcaldy, for a complete system of evaporating and deærating plant, including heaters and pumps. The deærating plant has a capacity of 72,000 lbs. of feed water per hour, while the evaporator produces 10 per cent. feed make-up, and consists of a twin evaporator with two vessels delivering into a common separator.

The Furnival Steel Company, of Sheffield, write drawing attention to a particularly objectionable instance of railway red tape. Most manufacturers, they point out, receive orders from merchants, who, to save carriage charges, give in confidence their customer's address so that the goods can go direct. The railway companies usually show on their consignment notes not only the town from which the goods have been sent, but also the maker's name, so that manufacturers frequently get inquiries direct for goods supplied through a merchant. The Furnival Steel Company think that trade associations should take up this matter as obviously it is most unfair to the intermediary who gets the business.

Mr. Barrington Hooper, C.B.E., chairman of the Publicity Committee of the International Advertising Convention at Philadelphia, and deputy-chairman and joint managing director of Industrial Newspapers, Limited, offers some valuable hints to British manufacturers in a letter to the "Daily Telegraph" on the value of publicity in overcoming the effects of the acute depression prevailing in the industries of this country. He writes that a few days ago the Prince of Wales urged us all to "buy British," in order to increase employment at home. Even more important is the need to "sell British," in order to keep our overseas trade balance right. To "sell British" abroad means advertising abroad. The best advertisement British goods can get this year will be during the International Advertising Convention at Philadelphia next June, when 10,000 advertisers and advertising agents from all over the world will meet to pool their knowledge and to exchange ideas. As chairman of the Publicity Committee Mr. Barrington Hooper urges all manufacturers and others who are in a position to do so to consider the question of attending the International Advertising Convention at Philadelphia. A powerful British delegation to the United States will do much to impress the American public with the prestige of Great Britain and so to stimulate the sale of British goods throughout the world. A very interesting programme is promised, and apart from the return fare the trip need not cost more than $100.

Contracts Open.

Basingstoke, April 6.—Supply and erection of one 600-b.h.p. vertical cylinder heavy oil engine and direct-coupled dynamo. F. Swarbrick, borough electrical engineer, Electricity Works, Basingstoke. (Fee, £2, returnable.)

Buenos Aires, May 3.—The Department of Navigation and Ports of the Argentine Ministry of Public Works require the supply and erection of an electric travelling crane of a maximum hoisting capacity of 1½ metric tons. The Department of Overseas Trade (Room 50), 35, Old Queen Street, London, S.W.1.

Colwyn Bay, April 8.—(1G) Wrought-iron gas and steam tubes and fittings; (2G) (a) cast-iron pipes and specials; (b) Mannesmann weldless steel main pipes, for the Urban District Council. The Gas Engineer, Council Offices, Colwyn Bay.

Colwyn Bay, April 8.—(1G) Copper tubes and fittubes; (6G) brass and gunmetal goods, for the Urban District Council. The Gas Engineer, Council Offices, Colwyn Bay.

Constantinople, April 17-20.—The Anatolian Railway Administration require zinc, lead, antimony, and other metals. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. Ref. AX. 2964.

Johannesburg, April 29.—168 tons of round copper bars, for fire-box stays, etc., for the South African Railways and Harbours. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Ref. A.X. 2941.)

London, E.C.2.—Supply and erection of circulating water pumps and pump-house equipment; circulating water screening plant; and boiler-house coal-handling plant, for the County of London Electric Supply Company, Limited. Mr. F. C. McQuown, joint manager and secretary, Moorgate Court, Moorgate Place, London, E.C.2. (Fee, £5 5s., returnable; £2 2s. for subsequent copies.)

Santiago, April 5.—Galvanised iron pipes and fittings and bronze cocks, for the Chilean Inspectorate of Water Supply and Drainage. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. Ref. A.X. 2950.)

Company Reports.

Henry Bessemer & Company, Limited.—Net profit, £1,307; debit balance reduced to £36,620.

Chesterfield Tube Company, Limited.—Dividend on preference shares for half-year ending March 31.

Howard & Bullough, Limited.—Third quarterly dividend, 10 per cent. per annum, less tax, on ordinary shares.

Coltness Iron Company, Limited.—Profit, £160,393; income-tax, £17,800; redemption and depreciation, £40,218; final dividend, ordinary shares, 2½ per cent. interim, 5 per cent.; carry forward, £68,045.

Bell's United Asbestos Company, Limited.—Balance dividend, 2s. per share on ordinary shares, making 12½ per cent. for year; staff pensions fund, £2,000; reserve, £8,000; carried forward, £34,961.

Stewarts & Lloyds, Limited.—Depreciation, £75,000; net profit, £291,119; dividends on preference and preferred ordinary shares, £93,626; dividend on deferred shares, 7½ per cent., £239,045; carried forward, £94,146; brought in, £135,698.

Gibbons (Dudley), Limited.—Net profit, £13,994; brought forward, £13,896; total, £27,890; preference dividend and interim dividends 7 per cent. per annum on ordinary (all free of tax), £11,462; final dividend, 3 per cent. per annum, free of tax, upon ordinary, making 10 per cent. for year.

Obituary.

Mr. J. Biddulph, of Lawton, North Staffs., who has died at the age of 87, was, at the time of his retirement, a manager at the Kidsgrove Iron Works.

Sir Bradford Leslie, the prominent engineer, died in London recently, in his 95th year. The deceased was apprenticed to Brunel, the famous bridge builder and engineer, and was associated with him until 1859. Under Brunel the foundations of Leslie's career as a builder of bridges were laid in his work at the Chepstow Bridge and at the Saltash Bridge, where he was resident engineer. Later, he was associated with Brunel in work on the "Great Eastern," the cable-layer. In 1858 he was appointed engineer in charge of bridges and viaducts on the Eastern Bengal Railway, India. As municipal engineer of Calcutta he also completed extensive schemes of water-supply and drainage. In 1895 he became chairman of the South Punjab Railway Company in London.

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IRON AND STEEL MARKETS.

Pig-Iron.

MIDDLESBROUGH.—With the Easter holidays in immediate prospect, business in the Cleveland iron market this week has been even quieter than usual and transactions of any note have been few and far between, leaving the position in the meantime quite unchanged from that previously reported. Alike in the home and export trade, buyers are simply marking time, while makers, having mostly well-filled order books extending over the month, are apparently content with the absorption of current output, as little iron is going into stock, the total now being probably lower than at any period in the history of the trade, with export quotations unchanged as follow, home prices being 6d. per ton less: No. 1, 73s.; No. 3, G.M.B., 70s. 6d.; No. 4 foundry, 69s. 6d.; and No. 4 forge, 68s. 6d. per ton.

The hematite position on Tees-side does not improve. Makers have still a fair volume of orders on their books, but they can do with more. The quotation for East Coast mixed numbers is now definitely down to 77s. per ton, the No. 1 quality being offered at a premium of 6d. per ton. On the North-West Coast, Bessemer mixed numbers are quoted from £4 5s. to £4 7s. 6d. per ton at Glasgow; £4 2s. 6d., c.i.f. at Welsh ports; £4 9s. to £4 10s. per ton at Sheffield; and £4 12s. 6d. to £4 13s. 6d. per ton at Birmingham.

LANCASHIRE.—In this district orders for pig-iron to replace those being completed at the furnaces are being issued very slowly and both inquiry and actual business have been inactive during the past week. Lincolnshire and Staffordshire foundry iron is still quoted at round 76s. per ton for No. 3, Derbyshire at 75s. to 76s., West Coast hematite at 93s. to 94s., and Scottish No. 3 at round 94s., prices which include delivery in all cases.

THE MIDLANDS.—Very little new business of any account is being transacted in local markets at the present time for foundry iron, and, as previously anticipated, the higher values at which iron was bought at the middle of the quarter are no longer obtainable. The majority of the bigger consumers are covered for their requirements, and there appears to be no disposition on their part at the moment to increase their commitments. Current prices for pig-iron are as follow:—Derbyshire No. 3 foundry, 66s. to 67s.; Staffordshire No. 3 foundry, 66s. 6d. to 67s. 6d.; Northants, No. 3 foundry, 62s. 6d. to 63s. 6d.

SCOTLAND.—The local pig-iron market continues cheerless, in spite of the trouble with the engineers having been adjusted without a stoppage. Consumers seem to have no interest in pig-iron except for their immediate needs, and prices are unchanged on the basis of 76s. 6d. for No. 3 foundry at the furnaces.

Finished Iron.

No new developments can be observed in connection with this class of material; prices are without change, varying from £11 up to, say, £11 7s. 6d. per ton for crown quality bars. The former price is easily obtainable for anything like a moderate specification for crown iron. The South Staffs. mills are having to cope not only with severe Continental competition, but also the lower prices which the Lancashire and Derbyshire works are prepared to quote. Of course, the local mills are hopelessly out of it when up against Continental competition for nut and bolt iron, as this material is offered freely delivered works in this locality at £6 12s. 6d. per ton, whereas the cheapest local product would not be under £10 5s. per ton. It is easy to imagine, therefore, that there is little sign of activity in business with local mills which manufacture this class of iron. The marked-bar makers, although they do not fear the French or Belgian competition, are not too well placed for business; things are anything but brisk with them, the majority of the mills having but a few weeks' work in hand. Marked bars are quoted at £14 per ton f.o.t., which figure has been operative for several months. None of the Staffs. works is in full-time operation.

Steel.

At Sheffield the steel-makers report no improvement, and some of the mills are idle again. Under these conditions, very little interest is being taken in pig-iron, and Scotch hematite is unchanged at 76s. 6d., and West Coast at 85s. 6d. English basic is offered at 74s. 6d., and Continental at 71s. 6d. at steelworks here. In the tinplate market prices remain generally unchanged, but lower values have been accepted here and there, and with some works coming to an end of their rolling programme, the immediate outlook is not encouraging. In this connection it is believed the pooling scheme will need to be revised, so that the output may be further restricted.

Scrap.

No very striking change in conditions can be reported in the markets for scrap metals, the volume of business transacted being only of moderate dimensions. In Lancashire, foundries are buying chiefly from hand to mouth, with ordinary machinery scrap on offer at about 70s. per ton, and textile quality at 72s. 6d. per ton, both delivered works. In Scotland, prices have not altered much, and are still being quoted at 74s. and 69s. per ton respectively. Steelworks cast-iron scrap is still around 67s. 6d. per ton, and for old cast-iron railway chairs 73s. 6d. to 74s. 6d. per ton. Light cast-iron scrap and firebars are still commanding 61s. to 62s. 6d. per ton, and some fair lots have been disposed of at these prices. The above prices are all per ton, delivered f.o.t. consumers' works.

Metals.

Copper.—The markets for base metals during the week have been quiet but steady, fluctuations in standard copper having been confined within narrow limits, evidencing the absence of speculative interest at the moment. The encouraging reports received regarding the domestic consumption of the United States, and also statements indicating increased trade activity in Germany, were the main factors causing holders to adopt a more reserved attitude periodically, but beyond this there is no change in conditions, and the outlook continues somewhat obscure. Current quotations:—*Cash*: Thursday, £58 2s. 6d.; Friday, £57 17s. 6d.; Monday, £57 15s.; Tuesday, £57 2s. 6d. *Three Months*: Thursday, £59 2s. 6d.; Friday, £58 15s.; Monday, £58 12s. 6d.; Tuesday, £58 2s. 6d.

Tin.—On March 17 tin advanced to the highest price recorded this year, and the depletion of supplies seems likely to become very pronounced under short shipments, combined with a renewal of heavy American deliveries. Demand for both spot and forward tin has been very active, although at times America has been rather a hesitating buyer. Stocks are still very small. The statistical outlook is now stronger than has been the case for many years. Current quotations:—*Cash*: Thursday, £287; Friday, £288 5s.; Monday, £287 15s.; Tuesday, £282. *Three Months*: Thursday, £279 10s.; Friday, £280 10s.; Monday, £280 10s.; Tuesday, £275 17s. 6d.

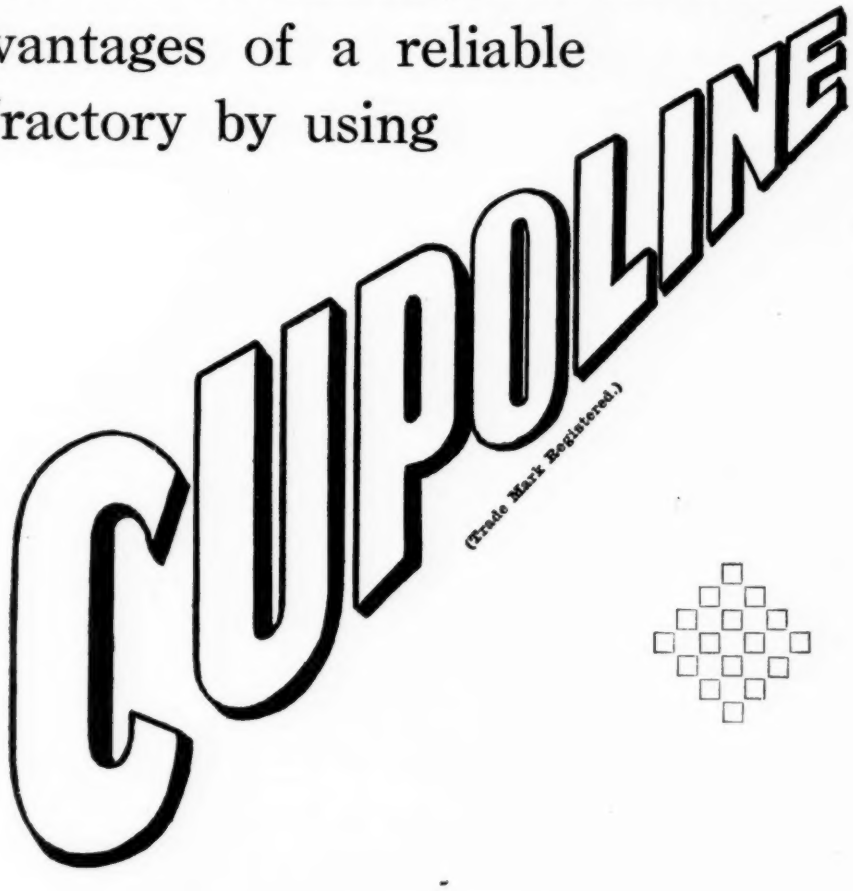
Spelter.—An unfavourable view of the statistical position has influenced a lower tendency in zinc values this week, while the consumptive demand at home has discouraged active buying. One of the chief factors in the decline is the discouraging conditions on the Continent, where stocks are rapidly accumulating. Imports of crude zinc in February totalled at 13,255 tons, against 12,753 tons in January. Current quotations:—*Ordinary*: Thursday, £33 2s. 6d.; Friday, £33 7s. 6d.; Monday, £33 5s.; Tuesday, £33 6s. 3d.

Lead.—The market for soft foreign pig continues in an unsatisfactory condition, with values still inclined to slightly lower levels, although steadier on the whole. Some weeks ago prices of lead were depressed very severely, but have since recovered to a remarkable extent in consequence of some support by dealers and better buying on consumptive account. Current quotations:—*Soft foreign (prompt)*: Thursday, £30 17s. 6d.; Friday, £30 12s. 6d.; Monday, £30 5s.; Tuesday, £30 6s. 3d.

General Sir Herbert Lawrence, of Glyn, Mills, Currie & Company, is stated to have been elected chairman of Vickers, Limited. Mr. Douglas Vickers, the present chairman, has been elected president of the reconstructed company. Sir Herbert Lawrence is already a director of the company.

The construction of the new tyre plant at the works of Henry Bessemer & Company, Limited, is not yet completed, but the buildings are finished. The cranes, one of the new hammers, the electric equipment, and the tyre mill are installed. Some parts of the new plant are already at work. The engineering shop in Forncett Street is proving a useful adjunct to Carlisle Street.

EFFICIENT SERVICE WITHOUT COSTLY UPKEEP, and all the advantages of a reliable refractory by using



Send for full particulars to:

ROBSON REFRACTORIES LTD.

1, North Road,

DARLINGTON, Durham.

Telephone : 2405. ***Telegrams : Cupoline, Darlington.***

CUPOLINE STORAGE DEPOTS AT:

Middlesbrough, Leith, Newcastle-on-Tyne, Newport (Mon.), Garston, Liverpool.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash ..	57	2	6
Three months ..	58	2	6
Electrolytic	64	5	0
Tough	60	10	0
Best selected ..	61	0	0
Sheets	90	0	0
India	74	0	0
Wire bars	65	5	0
Do. April	64	17	6
Do. May	64	17	6
Ingot bars	64	17	6
H.C. wire rods ..	69	0	0
Off. av. cash, Feb.	59	14	7½
Do., 3 mths. Feb.	60	14	8½
Do., Sttlmnt, Feb.	59	14	1½
Do., Electro, Feb.	66	12	6
Do., B.S., Feb. ..	64	0	0
Aver. spot price copper, Feb. ..	59	14	1½
Do., wire bars, Feb.	66	17	6
Solid drawn tubes		13d.	
Brazed tubes ..		13d.	
Wire		10d.	

BRASS.

Solid drawn tubes ..	12d.
Brazed tubes	13½d.
Rods, drawn	10½d.
Rods, extd. or rlld. ..	7½d.
Sheets to 10 w.g ..	10½d.
Wire	9½d.
Rolled metal	9½d.
Yellow metal rods ..	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets ..	8½d.

TIN.

	£	s.	d.
Standard cash ..	282	0	0
Three months ..	275	17	6
English	280	10	0
Bars	288	10	0
Straits	289	5	0
Australian	288	7	6
Eastern	283	10	0
Banca	288	10	0
Off.aver. cash, Feb.	287	4	9
Do., 3 mths.,Feb.	280	4	4½
Do., Sttlmt. Feb.	287	3	6
Aver. spot., Feb.	287	3	6

SPELTER.

	£	s.	d.
Ordinary	33	6	3
Remelted	33	10	0
Hard	27	10	0
Electro 99.9 ..	37	15	0
English	33	17	6
India	30	0	0
Zinc dust	42	0	0
Zinc ashes	14	10	0
Off. aver., Feb. ..	36	0	1¼
Aver., spot, Feb.	36	1	0¾

LEAD.

	£	s.	d.
Soft foreign ppt.	30	6	3
English	31	15	0
Off. average, Feb.	33	18	0¾
Average spot, Feb.	33	18	0¾

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	42	0	0
Do. V.M. ex whf.	40	0	0
Rods	46	0	0
Boiler plates ..	40	0	0
Battery plates ..	39	10	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	94	10	0
Chinese	81	0	0
Crude	56	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver ..	14	5	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon	
25%	9 10 0
45/50%	11 14 0
75%	20 12 6
Ferro-vanadium—	
35/40%	14/5 lb. va.
Ferro-molybdenum—	
70/75% c. free	6/- lb.
Ferro-titanium—	
23/25% carbonless	11½d. lb.
Ferro-phosphorus, 20/25%,	£17 0 0
Ferro-tungsten—	
80/85%,c.fr. ..	1/9½ lb.
Tungsten metal powder—	
98/99%	2/1 lb.
Ferro-chrome—	
2/4% car. ..	£35 0 0
4/6% car. ..	£22 17 6
6/8% car. ..	£21 15 0
8/10% car. ..	£20 17 6
Ferro-chrome—	
Max. 2% car.	£38 10 0
Max. 1% car.	£44 10 0
Max.0.70%car.	£54 10 0
70%,carbonless	1/5½ lb.
Nickel—99%,	
cubes or pellets ..	£170
Cobalt metal—98/99%	10/- lb.
Aluminium 98/99%	£112
Metallic Chromium—	
96/98% ..	3/3 lb.
Ferro-manganese (net)—	
76/80%, loose	£15 10 0
76/80%, packed	£16 10 0
76/80%, export	£15 0 0
Metallic manganese—	
94/96%, carbonless	2/- lb.
Per ton unless otherwise stated.	

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten ..	2	6
Finished bars, 18% tungsten ..	3	0
Per lb. net, d/d buyers' works.		
Extras—		
Rounds and squares 3 in. and over ..	4d.lb.	
Rounds and squares under ½ in. to ¼ in.	3d. lb.	
Do. under ¼in. to $\frac{3}{16}$ in.	1/- lb.	
Flats, ½in. × ¼in. to under 1 in. × ¾ in.	3d. lb.	
Do. under ½in. × ¼in.	1/- lb	
Bevels of approved sizes and sections	6d. lb.	
Bars cut to length	10% extra	
Scrap from high-speed tool steel—		
Scrap pieces	3d.	
Turnings and swarf	1d.	
Per lb. net, d/s steel makers' work		

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Hvy. steel	3	7	6 to	3	12	6
Bundled steel & shrngs.	3	3	6 to	3	7	6
Mixed iron & steel	3	2	6 to	3	5	0
Heavy cast iron	3	2	6 to	3	6	0
Good machinery for foundries	3	7	6 to	3	10	0
Cleveland—						
Heavy steel ..	3	4	6			
Steel turnings ..	2	7	6			
Cast iron borings	2	5	0			
Heavy forge ..	4	5	0			
Bushelled scrap	3	10	0			
Cast-iron scrap	3	5	6			
Lancashire—						
Cast-iron scrap	3	10	to 3	15	0	
Hvy. wrought	3	5	0 to 3	7	6	
Steel turnings ..	2	0	0			
London — Merchants' buying prices delivered yard.						
Copper (clean)..	50	0	0			
Brass (clean) ..	38	0	0			
Lead (less usual draft)	27	10	0			
Tea lead ..	23	0	0			
Zinc	24	0	0			
New aluminium cuttings ..	80	0	0			
Braziery copper	45	0	0			
Gunmetal ..	46	0	0			
Hollow pewter	190	0	0			
Shaped black pewter ..	144	0	0			

PIG-IRON.

(f.o.t. unless otherwise stated).

N.E. Coast—	
Foundry No. 1 ..	72/6
Foundry No. 3 ..	70/-
Foundry No. 4 ..	69/-
Forge No. 4	68/-
Hematite No. 1 ..	77/6
Hematite M/Nos. ..	77/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	86/3
,, d/d Birm.	93/3
Midlands—	
Staffs common* ..	—
,, No. 4 forge ..	62/6
,, No. 3 foundry	67/-
Shrops. basic	70/-
,, Cold blast, ord.*	185/-
,, ,, roll iron* ..	190/-
* d/d Birmingham.	
Northants forge	56/6
,, fdry No. 3 ..	63/-
Derbyshire forge ..	62/-
,, fdry. No. 3 ..	66/6
,, basic	65/-
Scotland—	
Foundry No. 1 ..	81/6
,, No. 3 ..	76/6
Hem. M/Nos.	76/6
Sheffield (d/d district)—	
Derby forge	66/-
,, fdry. No. 3 ..	70/6
Lincs. forge	67/6
,, fdry. No. 3 ..	70/-
E.C. hematite	87/6
W.C. hematite ..	89/6
Lincs. (at furnaces)—	
Forge No. 4	61/6
Foundry No. 3.. ..	64/-
Basic	64/-
Lancashire (d/d eq. Man.)—	
Derby forge	69/6
,, fdry. No. 3 ..	75/-
Northants foundry No. 3	75/9
Dalzell, No. 3	110/-
Summerlee, No. 3 ..	94/-
Glengarnock, No. 3 ..	94/-
Gartsherrie, No. 3 ..	94/-
Monkland No. 3	94/-
Coltness, No. 3	94/-
Shotts, No. 3	94/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars(cr.)	11	0	0 to	12	0	0
Angles	11	10	0			
Tees to 3 united ins.	12	0	0			
Nut and bolt	10	5	0 to	10	7	6
Hoops	14	0	0 to	15	0	0
Marked bars (Staffs.) f.o.t. ..	14	0	0			
Gas strip	12	10	0			
Bolts and nuts .. ¾ in. × 4 in. ..	15	15	0			
Steel—						
Ship plates	7	10	0 to	7	17	6
Boiler plts. ..	11	10	0			
Chequer plts. ..	9	15	0			
Angles £7	0	0 to	7	5	0	
Tees £8	0	0 to	8	5	0	
Joists £7	0	0 to	7	5	0	
Rounds and Squares 3 in. to 5½ ins. ..	8	0	0			
Rounds under 3 in. to ¾ in.	7	15	0			
Flats, over 5 in. wide and up ..	8	10	0			
Flats, 5in. to 1¼in.	7	10	0			
Rails, heavy ..	8	0	0			
Fishplates	12	0	0			
Hoops (Staffs.) ..	10	10	0			
Black sheets, 24g.	11	5	0			
Galv. cor. sheets, 24g.	16	0	0			
Galv. fencing wire 8g. plain	14	0	0			
Billets,soft £6	0	0 to	6	5	0	
Billets, hard ..	8	2	6			
Sheet bars	6	0	0 to	6	2	6
Tin bars d/d	6	2	6 to	6	5	0

PHOSPHOR BRONZE.

	Per lb.	basis.
Strip	1	3
Sheet to w.g.	1	3½
Wire	1	3½
Rods	1	3
Tubes	1	8
Castings	1	2

Delivery 3 cwt. free
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks ..	9d. to 1/5½
Ingots rolled to spoon size ..	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	23.26
No. 2 foundry, Valley	22.26
No. 2 foundry, Birm.	22.00
Basic	21.76
Bessemer	22.76
Malleable	22.26
Grey forge	21.76
Ferro-mang. 80% d/d	95.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	35.00
O.-h. billets	35.00
O.-h. sheet bars ..	36.00
Wire rods	45.00
	Cents.
Iron bars, Phila. ..	2.22
Steel bars	2.00
Tank plates	1.85
Beams, etc.	1.90
Skelp, grooved steel ..	1.90
Skelp, sheared steel ..	1.90
Steel hoops	2.50
Sheets, black, No. 28..	3.25
Sheets, galv., No. 28 ..	4.50
Sheets, blue an'l'd, 9 & 10	2.50
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv. ..	3.35
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry ..	32/6 to 37/6
,, furnace ..	20/- to 25/-
Durham & North.	
,, foundry	30/- to 33/-
,, furnace ..	15/-
Other Districts, foundry	30/- to 33/-
,, ,, furnace (basis)	11/9

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes,	20×14, box	19/4½
,,	28×20, ,,	38/9
,,	20×10, ,,	29/1½
,,	18¾×14, ,,	20/4½
C.W.	20×14, ,,	17/7½
,,	28×20, ,,	35/3
,,	20×10, ,,	24/1½
,,	18¾×14, ,,	18/4½

Terneplates 28×20, 35/9 per box basis f.o.b.

SWEDISH IRON.

Bars,hammered	£18/10 to £19/0
Rolled Ord.	£15/15/0 to £16/5/0
Nail rods	£16 5 0 to £16 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£9 to £12
Pig-iron	£6 10 0 to £7 0 0

all f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes	*Fittings*
Gas ..	60%	.. 50%
Water ..	55%	.. 45%
Steam ..	50%	.. 40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (Cash).

	£	s.	d.		
Mar. 25	58	2	6	dec.	7/6
,, 26	57	17	6	,,	5/-
,, 29	57	15	0	,,	2/6
,, 30	57	2	6	,,	12/6

Electrolytic Copper.

	£	s.	d.		
Mar. 25	64	15	0	dec.	15/-
,, 26	64	10	0	,,	5/-
,, 29	64	15	0	inc.	5/-
,, 30	64	5	0	dec.	10/-

Standard Tin (Cash).

	£	s.	d.		
Mar. 25	287	0	0	dec.	105/-
,, 26	288	5	0	inc.	25/-
,, 29	287	15	0	dec.	10/-
,, 30	282	0	0	,,	115/-

Tin (English ingots).

	£	s.	d.		
Mar. 25	285	10	0	dec.	110/-
,, 26	287	0	0	inc	30/-
,, 29	286	10	0	dec.	10/-
,, 30	280	10	0	,,	120/-

Zinc Sheets (English).

	£	s.	d.		
Mar. 25	42	0	0	dec.	10/-
,, 26	42	0	0	No change	
,, 29	42	0	0	,,	,,
,, 30	42	0	0	,,	,,

Spelter (ordinary).

	£	s.	d.		
Mar. 25	33	2	6	dec.	15/-
,, 26	33	7	6	inc.	5/-
,, 29	33	5	0	dec.	2/6
,, 30	33	6	3	inc.	1/3

Lead (English).

	£	s.	d.		
Mar. 25	32	5	0	dec.	15/-
,, 26	32	0	0	,,	5/-
,, 29	31	15	0	,,	5/-
,, 30	31	15	0	No change	

AVERAGE MONTHLY PRICES PER UNIT OF MANGANESE ORE.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1914	10	9½	9½	9½	9.55	9½	9½	*	*	11.9	11.5	11.5	11.07
1915	1 0.3	1 2.63	1 4	1 4	1 8	1 9.88	1 10½	1 8.63	1 8	1 8	1 10.15	2 3.8	1 8.31
1916	2 7½	2 8	2 8	2 7½	2 6	2 6	2 6	2 6	2 7.6	2 8	*	*	2 7.08
1917													
1918			Prices pro hibited.										
1919					2 1½	*	2 2½	2 2.3	2 3.13	2 4.4	2 6½	2 7½	2 4.08
1920	2 11.8	3 6½	3 11½	4 1.8	4 5½	4 5½	4 3	4 1.13	4 0	3 9½	3 7½	2 10.7	3 10.19
1921	2 3.63	2 0½	1 8½	1 5.1	1 4½	1 2½	1 2.13	1 2.13	1 1.7	1 2½	1 1.94	1 2.06	1 5.15
1922	1 1.63	1 1.44	1 1.1	1 1	1 1.25	1 1.7	1 2.31	1 2.13	1 2.1	1 2.13	1 2.63	1 2.95	1 1.86
1923	1 3.63	1 6.38	1 9.3	1 9½	1 10	1 10	1 9½	1 9	1 9.13	1 9	1 9	1 9½	1 7.89
1924	1 10.88	1 11.2	1 11	1 11¾	2 0	1 11¾	1 11 5/6	1 11	1 10½	1 10½	1 10	1 9¾	1 10.94
1925	1 10	1 10	1 10½	1 11	1 11	1 10½	1 9½	1 8½	1 8¼	1 7½	1 8½	1 8¾	1 9½
1926	1 8¾	1 7¾	1 8	—	—	—	—	—	—	—	—	—	—

* Not quoted.

AVERAGE MONTHLY PRICES OF FERRO-MANGANESE (80 PER CENT.)

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1914	9 12 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	11 0 0	12 5 0	11 6 3	10 7 6	10 7 6	9 10 8½
1915	11 0 6	12 10 0	14 10 0	15 0 0	17 15 0	20 0 0	20 0 0	20 0 0	20 0 0	20 0 0	20 0 0	20 0 0	17 11 3½
1916	20 0 0	22 10 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	52 0 0	25 0 0	25 0 0	25 0 0	23 10 10
1917	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0
1918	25 0 0	26 10 0	25 0 0	*	*	*	*	*	*	*	*	*	25 10 0
1919	*	*	*	*	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	24 10 0	23 0 0	25 10 0	24 14 3
1920	27 18 0	30 0 0	31 17 6	35 0 0	37 0 0	37 0 0	37 0 0	37 0 0	37 0 0	37 0 0	36 10 0	33 16 0	34 15 1½
1921	31 0 0	27 5 0	23 12 6	21 18 0	21 0 0	18 0 0	18 0 0	18 0 0	17 2 0	16 0 0	15 6 0	15 0 0	20 3 1½
1922	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0
1923	15 0 0	15 0 0	16 0 0	17 5 0	18 0 0	18 0 0	18 0 0	18 0 0	18 0 0	17 15 0	17 0 0	17 0 0	17 1 8
1924	17 0 0	17 0 0	17 0 0	17 0 0	17 0 0	17 0 0	16 10 0	14 10 0	13 10 0	13 10 0	14 3 4	14 15 0	15 14 10½
1925	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0
1926	15 10 0	15 10 0	15 10 0	—	—	—	—	—	—	—	—	—	—

* Not quoted.

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

18, BENNETTS HILL, BIRMINGHAM.
11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT.
FOWLERS BUILDINGS, BOMBAY.
CLIVE STREET, CALCUTTA.
ANGAPPA NAICK STREET, MADRAS.

REGISTERED TRADE MARK

1, HONG KONG ROAD, SHANGHAI.
OCEAN BUILDING, SINGAPORE.
JAVA STREET, KUALA LUMPUR
5, SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.
P.O. BOX 1580, CAIRO.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.,

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE

WILLIAM JACKS & COMPANY,

93, HOPE STREET, GLASGOW.

ROYAL EXCHANGE, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

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